

# **BIRLA INSTITUTE OF TECHNOLOGY**



## **CHOICE BASED CREDIT SYSTEM (CBCS) CURRICULUM**

*(Effective from Academic Session: Monsoon 2018)*

### **NAME OF THE PROGRAMME**

**B.TECH. Electronics and Communication Engineering**

### **NAME OF THE DEPARTMENT**

**Department of Electronics and Communication Engineering**

## **Institute Vision**

To become a Globally Recognised Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research, and technological service to the National needs.

## **Institute Mission**

- To educate students at Under Graduate, Post Graduate, Doctoral, and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.
- To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
- To develop effective teaching learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education, and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

### **Department Vision:**

To become a centre of excellence in teaching and research for creating technical manpower to meet the technological, societal and environmental needs of the country in the field of Electronics and Communication Engineering.

### **Department Mission**

- To offer state of the art education of global standards through innovative methods of teaching and learning with practical orientation aiming to prepare the students for successful career and to provide required technological services.
- To prepare the students to think independently, take initiative, lead a team in an organization, take responsibility and solve the problems related to industry, society, environmental, health, safety, legal and cultural issues maintaining the professional ethics.
- To pursue high quality contemporary research through continued interaction with research organizations and industries.

### **Graduate Attributes**

1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.
4. **Conduct investigations of complex problems** using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.
5. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
7. **Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.
11. **Project Management and Finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and life- long learning in the broadest context of technological change.

### **Programme Educational Objectives (PEOs)**

1. To develop an ability to apply the knowledge acquired in basic sciences and engineering for solving Electronics and Communication Engineering problems with regards to technical, economic, environmental and social contexts.
2. To build confident and competent graduates capable of designing and testing electronic devices and communication systems for the given specifications.
3. To inculcate an attitude to work in a team using technical knowhow, software tools and interdisciplinary working environments to achieve project goals.
4. To nurture effective communication and interpersonal skills to demonstrate leadership qualities, and exhibit professional ethics.
5. To develop an ability, enthusiasm and understanding for life-long learning development and motivation towards higher studies and research.

## (A) Programme Outcomes (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**(B) Programme Specific Outcomes (PSOs)**

1. Apply the knowledge acquired in basic sciences and engineering for solving electronics and communication engineering problems.
2. Build competence in design and analysis of electronics and communication systems.
3. Develop skills to carry out research in electronic instrumentation, signal processing, VLSI systems, microwave engineering, wireless communication and networking.

**PROGRAMME COURSE STRUCTURE (ALL SEMESTERS)**

**BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI  
NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19**

**Based on CBCS & OBE model**

**Recommended scheme of study**

*(B.Tech. in Electronics & Communications Engineering, Computer Science & Engineering, Electrical & Electronics Engineering, Information Technology)*

| Semester/ Session<br>of Study<br>(Recommended) | Course Level             | Category<br>of course                | Course<br>Code        | Course   | Mode of delivery & credits<br><i>L-Lecture; T-Tutorial;<br/>P-Practical</i> |   |   | Total<br>Credits<br>C- Credits |           |
|--|--------------------------|--------------------------------------|-----------------------|--|---|---|---|--------------------------------|-----------|
|  |                          |                                      |                       |  | L   | T | P |                                | C         |
|  |                          | <b>THEORY</b>                        |                       |  |   |   |   |                                |           |
| <b>FIRST<br/>Monsoon</b>                       | <b>FIRST</b>             | FS<br><i>Foundation<br/>Sciences</i> | MA 103                | Mathematics - I  | 3   | 1 | 0 | 4                              |           |
|  |                          |                                      | CH101                 | Chemistry  | 3   | 1 | 0 | 4                              |           |
|  |                          | GE<br><i>General<br/>Engineering</i> | EC101                 | Basics of Electronics &<br>Communication Engineering   | 3   | 1 | 0 | 4                              |           |
|  |                          |                                      | ME101                 | Basics of Mechanical Engineering                       | 3   | 1 | 0 | 4                              |           |
|  |                          |                                      | <b>LABORATORIES</b>   |  |   |   |   |                                |           |
|  | <b>FIRST</b>             | FS                                   | CH102                 | Chemistry Lab  | 0   | 0 | 3 | 1.5                            |           |
|  |                          | GE                                   | EC102                 | Electronics & Communication<br>Lab                     | 0   | 0 | 3 | 1.5                            |           |
|  |                          | GE                                   | ME102                 | Engineering Graphics                                   | 0   | 0 | 4 | 2                              |           |
|  |                          | MC<br>Mandatory Course               | MC101/10<br>2/103/104 | Choice of : NCC/NSS/<br>PT & Games/ Creative Arts (CA) | 0   | 0 | 2 | 1                              |           |
|  | <b>TOTAL</b>             |                                      |                       |  |   |   |   |                                | <b>22</b> |
|  |                          |                                      | <b>THEORY</b>         |  |   |   |   |                                |           |
|  | <b>SECOND<br/>Spring</b> | <b>FIRST</b>                         | FS                    | MA107  | Mathematics - II  | 3 | 1 | 0                              | 4         |
| PH113  |                          |                                      |                       | Physics  | 3   | 1 | 0 | 4                              |           |
| GE   |                          |                                      | CS101                 | Programming for problem Solving                        | 3   | 1 | 0 | 4                              |           |
|  |                          |                                      | EE101                 | Basics of Electrical Engineering                       | 3   | 1 | 0 | 4                              |           |
|  |                          |                                      | <b>LABORATORIES</b>   |  |   |   |   |                                |           |
| <b>FIRST</b>                                   |                          | FS                                   | PH114                 | Physics Lab  | 0   | 0 | 3 | 1.5                            |           |
|  |                          | GE                                   | CS102                 | Programming for problem Solving<br>lab                 | 0   | 0 | 3 | 1.5                            |           |
|  |                          |                                      | PE101                 | Workshop Practice                                      | 0   | 0 | 3 | 1.5                            |           |
|  |                          | MC                                   | MC105/10<br>6/107/108 | Choice of : NCC/NSS/<br>PT & Games/ Creative Arts (CA) | 0   | 0 | 2 | 1                              |           |
| <b>TOTAL</b>                                   |                          |                                      |                       |  |   |   |   | <b>21.5</b>                    |           |
| <b>GRAND TOTAL FOR FIRST YEAR</b>              |                          |                                      |                       |  |   |   |   | <b>43.5</b>                    |           |

**BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI**  
**NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19**  
**Based on CBCS & OBE model**  
**Recommended scheme of study**  
***B.Tech. in Electronics & Communications Engineering***

| Semester/ Session of Study (Recommended) | Course Level | Category of course  | Course Code               | Courses                          | Mode of delivery & credits<br><i>L-Lecture; T-Tutorial; P-Practicals</i> |                         |                         | Total Credits<br><i>C- Credits</i> |             |
|--|--------------|---------------------|---------------------------|----------------------------------|--|-------------------------|-------------------------|------------------------------------|-------------|
|  |              |                     |                           |                                  | L<br>(Periods/<br>week )   | T<br>(Periods/<br>week) | P<br>(Periods/<br>week) | C                                  |             |
| THIRD<br>Monsoon                         |              | <b>THEORY</b>       |                           |                                  |  |                         |                         |                                    |             |
|  | FIRST        | FS                  | BE101                     | Biological Science for Engineers | 2  | 0                       | 0                       | 2                                  |             |
|  | SECOND       | PC                  | GE                        | IT 201                           | Basics of Intelligent Computing  | 3                       | 0                       | 0                                  | 3           |
|  |              |                     | EE205                     | Circuit Theory                   | 3  | 1                       | 0                       | 4                                  |             |
|  |              |                     | EC201                     | Electronic Devices               | 3  | 0                       | 0                       | 3                                  |             |
|  |              |                     | EC203                     | Digital System Design            | 3  | 0                       | 0                       | 3                                  |             |
|  |              |                     |                           | EC205                            | Signals and Systems  | 3                       | 0                       | 0                                  | 3           |
|  |              | <b>LABORATORIES</b> |                           |                                  |  |                         |                         |                                    |             |
|  | FIRST        | GE                  | EE102                     | Electrical Engineering lab       | 0  | 0                       | 3                       | 1.5                                |             |
|  | SECOND       | PC                  | MC                        | MC201/202/203/204                | Choice of : NCC/NSS/PT & Games/ Creative Arts (CA)                       | 0                       | 0                       | 2                                  | 1           |
|  |              |                     | EC202                     | Electronic Devices Lab           | 0  | 0                       | 3                       | 1.5                                |             |
|  |              |                     | EC204                     | Digital System Design Lab        | 0  | 0                       | 3                       | 1.5                                |             |
|  |              |                     | EC208                     | Electronic Measurements Lab      | 0  | 0                       | 4                       | 2                                  |             |
|  | <b>TOTAL</b> |                     |                           |                                  |  |                         |                         |                                    | <b>25.5</b> |
| FOURTH<br>Spring                         |              | <b>THEORY</b>       |                           |                                  |  |                         |                         |                                    |             |
|  | SECOND       | FS                  | MA203                     | Numerical Methods                | 2  | 0                       | 0                       | 2                                  |             |
|  | FIRST        | FS                  | CE101                     | Environmental Science            | 2  | 0                       | 0                       | 2                                  |             |
|  | SECOND       | PC                  | EC251                     | Probability and Random Processes | 3  | 0                       | 0                       | 3                                  |             |
|  |              |                     | EC253                     | Analog Circuits                  | 3  | 0                       | 0                       | 3                                  |             |
|  |              |                     | EC255                     | Analog Communication             | 3  | 0                       | 0                       | 3                                  |             |
|  |              |                     | EC257                     | Electromagnetic Fields and Waves | 3  | 0                       | 0                       | 3                                  |             |
|  |              | <b>LABORATORIES</b> |                           |                                  |  |                         |                         |                                    |             |
|  | SECOND       | PC                  | FS                        | MA204                            | Numerical Methods Lab  | 0                       | 0                       | 2                                  | 1           |
|  |              |                     | GE                        | IT202                            | Basic IT Workshop (Common Subject)                                       | 0                       | 0                       | 2                                  | 1           |
|  |              |                     | MC                        | MC205/206/207/208                | Choice of : NCC/NSS/PT & Games/ Creative Arts (CA)                       | 0                       | 0                       | 2                                  | 1           |
| EC254                                    |              |                     | Analog Circuits Lab       | 0                                | 0  | 3                       | 1.5                     |                                    |             |
| EC258                                    |              |                     | Electromagnetic Waves Lab | 0                                | 0  | 3                       | 1.5                     |                                    |             |
| <b>TOTAL</b>                             |              |                     |                           |                                  |  |                         |                         | <b>22</b>                          |             |



|   |        |       |   |  |   |   |     |                 |  |
|---|--------|-------|---|--|---|---|-----|-----------------|--|
| FIFTH Monsoon   | THIRD  | PC    | EC301                                   | Digital Communication                    | 3 | 0 | 0   | 3               |  |
|   |        |       | EC303                                   | Microprocessors and Microcontrollers     | 3 | 0 | 0   | 3               |  |
|   |        |       | EC305                                   | Signal Processing Techniques             | 3 | 0 | 0   | 3               |  |
|   |        |       | EC307                                   | Fundamentals of Data Communication       | 3 | 0 | 0   | 3               |  |
|   |        | PE    |   | Program Elective-I                       | 3 | 0 | 0   | 3               |  |
|   | OE     |       | Open Elective-I                         | 3  | 0 | 0 | 3   |                 |  |
|   |        |       | <b>LABORATORIES</b>                     |  |   |   |     |                 |  |
|   | THIRD  | PC    | EC302                                   | Communication System Lab                 | 0 | 0 | 4   | 2               |  |
|   |        |       | EC304                                   | Microprocessors and Microcontrollers Lab | 0 | 0 | 3   | 1.5             |  |
|   |        |       | EC306                                   | Signal Processing Lab                    | 0 | 0 | 3   | 1.5             |  |
| <b>TOTAL</b>  |        |       |   |  |   |   |     | <b>23</b>       |  |
| <b>Student may choose subjects of minor/specialization from 5th semester and onwards.</b> |        |       |   |  |   |   |     |                 |  |
| SIXTH Spring  | THIRD  | PC    | EC351                                   | Fiber Optic Communication                | 3 | 0 | 0   | 3               |  |
|   |        |       | EC353                                   | Pulse, Digital and Switching System      | 3 | 0 | 0   | 3               |  |
|   |        |       | EC379                                   | Control Systems                          | 3 | 0 | 0   | 3               |  |
|   |        | PE    |   | Program Elective-II                      | 3 | 0 | 0   | 3               |  |
|   |        | OE    |   | Open Elective-II                         | 3 | 0 | 0   | 3               |  |
|   | FIRST  | HSS   | MT123                                   | Business Communications                  | 3 | 0 | 0   | 3               |  |
|   | THIRD  | MC    | MC300                                   | Summer training - Mandatory              |   |   |     | 2               |  |
|   | SECOND | HSS   | MT204                                   | Constitution of India                    | 2 | 0 | 0   | 0<br>Non-credit |  |
|   |        |       | <b>LABORATORIES</b>                     |  |   |   |     |                 |  |
|   | THIRD  | PC    | EC352                                   | Fiber Optic Communication Lab            | 0 | 0 | 3   | 1.5             |  |
| PC  |        | EC354 | Pulse, Digital and Switching System Lab | 0  | 0 | 3 | 1.5 |                 |  |
| <b>TOTAL</b>  |        |       |   |  |   |   |     | <b>23</b>       |  |
| SEVENTH Monsoon   | FOURTH | PC    | EC401                                   | Industrial Electronics                   | 3 | 0 | 0   | 3               |  |
|   |        |       | EC403                                   | Professional Practice Law & Ethics       | 2 | 0 | 0   | 2               |  |
|   |        | PE    |   | Program Elective-III                     | 3 | 0 | 0   | 3               |  |
|   |        |       |   | Program Elective-IV                      | 3 | 0 | 0   | 3               |  |
|   |        | OE    |   | Open Elective-III                        | 3 | 0 | 0   | 3               |  |
|   |        |       |   | Open Elective-IV                         | 3 | 0 | 0   | 3               |  |
|   |        | PROJ  | EC400M                                  | Minor Project                            | - | - | -   | 3               |  |
| <b>TOTAL</b>  |        |       |   |  |   |   |     | <b>20</b>       |  |
| EIGHT Spring  | FOURTH | PROJ  | EC400                                   | Research Project/ Industry Internship    | - | - | -   | 10              |  |
| <b>TOTAL</b>  |        |       |   |  |   |   |     | <b>10</b>       |  |
| <b>GRAND TOTAL</b><br><i>Minimum requirement for Degree award</i>                         |        |       |   |  |   |   |     | <b>167</b>      |  |

**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**  
**PROGRAMME ELECTIVES (PE)\***  
**OFFERED FOR LEVEL 1-4**

| PE / LEVEL   | Code no. | Name of the PE courses                     | Prerequisite/Corequisite courses with code   | L | T | P | C |
|--|----------|--|--|---|---|---|---|
| <b>PE-I</b>  |          |  |  |   |   |   |   |
| PE/Level-3<br>(MO) SEM-V   | EC309    | Adaptive Signal Processing                 | EC305 Signal Processing Techniques   | 3 | 0 | 0 | 3 |
|  | EC311    | Digital Signal Processor                   | EC305 Signal Processing Techniques   | 3 | 0 | 0 | 3 |
|  | EC313    | Electronic Measurements                    | EC208 Electronic Measurement Lab   | 3 | 0 | 0 | 3 |
|  | EC315    | Introduction to Industrial Instrumentation | EC208 Electronic Measurement Lab   | 3 | 0 | 0 | 3 |
|  | EC319    | VLSI Systems                               | EC101 Basics of Electronics and Communication Engineering,<br>EC201 Electronic Devices                             | 3 | 0 | 0 | 3 |
|  | EC321    | Microelectronic Devices and Circuits       | EC101 Basics of Electronics and Communication Engineering,<br>EC201 Electronic Devices                             | 3 | 0 | 0 | 3 |
|  | EC323    | Microwave Theory and Techniques            | EC257 Electromagnetic Fields and Waves   | 3 | 0 | 0 | 3 |
|  | EC325    | Antenna and Wave Propagation               | EC257 Electromagnetic Fields and Waves   | 3 | 0 | 0 | 3 |
|  | EC327    | Mobile & Cellular Communication            | EC255 Analog Communication,<br>EC301 Digital Communication   | 3 | 0 | 0 | 3 |
|  | EC329    | Information Theory and Coding              | EC251 Probability and Random Process,<br>EC255 Analog Communication  | 3 | 0 | 0 | 3 |
|  | EC331    | Issues in Nanoscale CMOS Design            | EC101 Basics of Electronics and Communication Engineering,<br>EC201 Electronic Devices                             | 3 | 0 | 0 | 3 |
| <b>* PROGRAMME ELECTIVES TO BE OPTED ONLY BY THE DEPARTMENT STUDENTS</b> |          |  |  |   |   |   |   |
| PE / LEVEL   | Code no. | Name of the PE courses                     | Prerequisite/Corequisite courses with code   | L | T | P | C |
| <b>PE-II</b>   |          |  |  |   |   |   |   |
| PE/Level-3<br>(SP) SEM-VI  | EC355    | Time Frequency and Wavelet Transform       | EC205 Signals and Systems,<br>EC305 Signal Processing Techniques<br>EC251 Probability and Random Processes         | 3 | 0 | 0 | 3 |
|  | EC357    | Speech and Audio Processing                | EC205 Signals and Systems,<br>EC305 Signal Processing Techniques<br>EC251 Probability and Random Processes         | 3 | 0 | 0 | 3 |
|  | EC359    | Microcontrollers and Interfacing           | EC303 Microprocessors and Microcontrollers   | 3 | 0 | 0 | 3 |
|  | EC361    | Digital Systems Design with FPGAs          | EC101 Basics of Electronics and Communication Engineering, EC201 Electronic Devices<br>EC203 digital System Design | 3 | 0 | 0 | 3 |
|  | EC363    | Nanoelectronics                            | EC101 Basics of Electronics and Communication Engineering,<br>EC201 Electronic Devices                             | 3 | 0 | 0 | 3 |
|  | EC365    | Radar and Navigation System                | EC257 Electromagnetic Fields and Waves   | 3 | 0 | 0 | 3 |
|  | EC367    | Computer Networking                        | EC307 Fundamentals of Data Communication   | 3 | 0 | 0 | 3 |
|  | EC369    | Wireless Networks                          | EC307 Fundamentals of Data Communication   | 3 | 0 | 0 | 3 |

|  | EC371    | Introduction to Electromagnetic Compatibility | EC257 Electromagnetic Fields and Waves   | 3 | 0 | 0 | 3 |
|--|----------|---|--|---|---|---|---|
|  | EC373    | Introduction to Sensors and Transducers       | EC208 Electronic Measurement Lab   | 3 | 0 | 0 | 3 |
|  | EC375    | High Speed Electronics                        | EC101 Basics of Electronics and Communication Engineering,   | 3 | 0 | 0 | 3 |
|  | EC381    | Error correcting Codes                        | EC329 Information Theory and Coding  | 3 | 0 | 0 | 3 |
|  | EC383    | DSP Architecture for VLSI                     | EC331 VLSI Systems<br>EC305 Signal Processing Techniques   | 3 | 0 | 0 | 3 |
|  | EC385    | Physical Design Automation                    | EC331 VLSI Systems   | 3 | 0 | 0 | 3 |
|  | EC387    | Wireless Communication                        | EC255 Analog Communication,<br>EC301 Digital Communication   | 3 | 0 | 0 | 3 |
|  | EC389    | Radar Signal Analysis                         | EC323 Microwave Theory and Techniques  | 3 | 0 | 0 | 3 |
| <b>* PROGRAMME ELECTIVES TO BE OPTED ONLY BY THE DEPARTMENT STUDENTS</b> |          |   |  |   |   |   |   |
| PE / LEVEL   | Code no. | Name of the PE courses                        | Prerequisite/Corequisite courses with code   | L | T | P | C |
| <b>PE-III</b>  |          |   |  |   |   |   |   |
| PE/Level-4(MO) SEM-VII   | EC405    | Digital Image & Video Processing              | EC305 Signal Processing Techniques   | 3 | 0 | 0 | 3 |
|  | EC407    | Multichannel Signal Processing                | EC305 Signal Processing Techniques   | 3 | 0 | 0 | 3 |
|  | EC409    | Fiber Optic Sensors                           | EC351 Fiber Optic Communication  | 3 | 0 | 0 | 3 |
|  | EC411    | Mixed Signal Design                           | EC101 Basics of Electronics and Communication Engineering,<br>EC201 Electronic Devices                     | 3 | 0 | 0 | 3 |
|  | EC413    | Real Time Embedded System                     | EC203 Digital System Design<br>EC303 Microprocessors and Microcontrollers                                  | 3 | 0 | 0 | 3 |
|  | EC415    | Semicustom IC Design                          | EC101 Basics of Electronics and Communication Engineering,<br>EC201 Electronic Devices                     | 3 | 0 | 0 | 3 |
|  | EC419    | Satellite Communication                       | EC255 Analog Communication,<br>EC301 Digital Communication   | 3 | 0 | 0 | 3 |
|  | EC421    | Bio-Medical Electronics & Signal Processing   | EC205 Signals and Systems,<br>EC305 Signal Processing Techniques<br>EC207 Probability and Random Processes | 3 | 0 | 0 | 3 |
| <b>* PROGRAMME ELECTIVES TO BE OPTED ONLY BY THE DEPARTMENT STUDENTS</b> |          |   |  |   |   |   |   |
| PE / LEVEL   | Code no. | Name of the PE courses                        | Prerequisite/Corequisite courses with code   | L | T | P | C |
| <b>PE-IV</b>   |          |   |  |   |   |   |   |
|  | EC423    | Radar Engineering                             | EC257 Electromagnetic Fields and Waves   |   |   |   |   |
|  | EC425    | Optoelectronic devices                        | EC351 Fiber Optic Communication  | 3 | 0 | 0 | 3 |
|  | EC427    | Neural Networks and Fuzzy System              | EC205 Signals and Systems,<br>EC305 Signal Processing Techniques   | 3 | 0 | 0 | 3 |
|  | EC429    | Device Modeling & Simulation                  | EC101 Basics of Electronics and Communication Engineering,<br>EC201 Electronic Devices                     | 3 | 0 | 0 | 3 |
|  | EC431    | Multimedia Communication                      | EC255 Analog Communication,<br>EC301 Digital Communication   | 3 | 0 | 0 | 3 |
|  | EC433    | Low Power VLSI Circuits                       | EC101 Basics of Electronics and Communication Engineering,<br>EC201 Electronic Devices                     | 3 | 0 | 0 | 3 |

|  |       |                               |  |   |   |   |   |
|--|-------|-------------------------------|--|---|---|---|---|
| <b>PE/Level-4(MO) VII SEM</b>  | EC435 | ASIC Design                   | EC101 Basics of Electronics and Communication Engineering,<br>EC201 Electronic Devices<br>EC331 VLSI Systems | 3 | 0 | 0 | 3 |
|  | EC437 | VLSI System Testing           | EC101 Basics of Electronics and Communication Engineering, EC201 Electronic Devices                          | 3 | 0 | 0 | 3 |
|  | EC439 | Integrated Circuit Technology | EC101 Basics of Electronics and Communication Engineering, EC201 Electronic Devices                          | 3 | 0 | 0 | 3 |
|  | EC447 | Electronic Packaging          | EC101 Basics of Electronics and Communication Engineering,<br>EC201 Electronic Devices<br>EC331 VLSI Systems | 3 | 0 | 0 | 3 |
|  | EC449 | Wireless Sensors networks     | EC307 Fundamentals of Data Communication   | 3 | 0 | 0 | 3 |
| <b>* PROGRAMME ELECTIVES TO BE OPTED ONLY BY THE DEPARTMENT STUDENTS</b> |       |                               |  |   |   |   |   |

**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING OPEN  
ELECTIVES (OE)\*  
OFFERED FOR LEVEL 1-4**

| <b>OE / LEVEL</b>  | <b>Code No.</b> | <b>Name of the OE courses</b>            | <b>Prerequisites courses with code</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|--------------------|-----------------|--|--|----------|----------|----------|----------|
|                    |                 | <b>OE-I</b>                              |  |          |          |          |          |
| OE/Level-3<br>(MO) | EC333           | Sensors and Transducers                  | N/A                                    | 3        | 0        | 0        | 3        |
|                    | EC335           | Consumer Electronics                     | N/A                                    | 3        | 0        | 0        | 3        |
|                    |                 | <b>OE-II</b>                             |  |          |          |          |          |
| OE/Level-3<br>(SP) | EC377           | Introduction to Communication System     | N/A                                    | 3        | 0        | 0        | 3        |
|                    |                 | <b>OE-III</b>                            |  |          |          |          |          |
| OE/Level-4<br>(MO) | EC441           | Introduction to MEMS                     | N/A                                    | 3        | 0        | 0        | 3        |
|                    | EC443           | Introduction to Human- Machine Interface | N/A                                    | 3        | 0        | 0        | 3        |
|                    |                 | <b>OE-IV</b>                             |  |          |          |          |          |
|                    | EC445           | Introduction to Signal Processing        | N/A                                    | 3        | 0        | 0        | 3        |

**\* OPEN ELECTIVES TO BE OPTED ONLY BY OTHER DEPARTMENT STUDENTS**

**BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI**  
**NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19**  
**Based on CBCS & OBE model**  
**Recommended scheme of study for**  
***In-depth Specialisation in Signal Processing***

| Semester/ Session of Study (Recommended)   | Course Level        | Category of course | Course Code | Courses                              | Mode of delivery & credits<br><i>L-Lecture; T-Tutorial;P-Practicals</i> |   |   | Total Credits<br><i>C- Credits</i> |     |
|--|---------------------|--------------------|-------------|--------------------------------------|---|---|---|------------------------------------|-----|
|  |                     |                    |             |                                      | L   | T | P |                                    | C   |
| <b>THEORY</b>  |                     |                    |             |                                      |   |   |   |                                    |     |
| FIFTH Monsoon  | THIRD               | PE                 | EC309       | Adaptive Signal Processing           | 3   | 0 | 0 | 3                                  |     |
|  |                     |                    | EC311       | Digital Signal Processor             | 3   | 0 | 0 | 3                                  |     |
|  | <b>LABORATORIES</b> |                    |             |                                      |   |   |   |                                    |     |
|  | THIRD               | PC                 | EC312       | Digital Signal Processor Lab         | 0   | 0 | 3 | 1.5                                |     |
| <b>TOTAL</b>   |                     |                    |             |                                      |   |   |   | <b>7.5</b>                         |     |
| SIXTH Spring   | THIRD               | PE                 | EC355       | Time Frequency and Wavelet Transform | 3   | 0 | 0 | 3                                  |     |
|  |                     |                    | EC357       | Speech and Audio Processing          | 3   | 0 | 0 | 3                                  |     |
|  | <b>LABORATORIES</b> |                    |             |                                      |   |   |   |                                    |     |
|  |                     | THIRD              | PC          | EC356                                | Time Frequency and Wavelet Transform Lab                                | 0 | 0 | 3                                  | 1.5 |
| <b>TOTAL</b>   |                     |                    |             |                                      |   |   |   | <b>7.5</b>                         |     |
| SEVENTH Monsoon  | FOURTH              | PE                 | EC405       | Digital & Video Image Processing     | 3   | 0 | 0 | 3                                  |     |
|  | <b>LABORATORIES</b> |                    |             |                                      |   |   |   |                                    |     |
|  |                     | FOURTH             | PC          | EC406                                | Image Processing Lab  | 0 | 0 | 4                                  | 2   |
| <b>TOTAL</b>   |                     |                    |             |                                      |   |   |   | <b>5</b>                           |     |
| <b>GRAND TOTAL</b><br><i>Minimum requirement for In-depth Specialisation award</i> |                     |                    |             |                                      |   |   |   | <b>20</b>                          |     |

**BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI**  
**NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19 Based on CBCS & OBE model**  
**Recommended scheme of study for**  
***In-depth Specialisation in Electronic Instrumentation***

| Semester/ Session of Study (Recommended) | Course Level | Category of course | Course Code | Courses                                    | Mode of delivery & credits<br><i>L-Lecture; T-Tutorial;P-Practicals</i> |   |   | Total Credits<br><i>C- Credits</i> |
|--|--------------|--------------------|-------------|--|---|---|---|------------------------------------|
|  |              |                    |             |  | L   | T | P |                                    |
| <b>THEORY</b>                            |              |                    |             |  |   |   |   |                                    |
| FIFTH                                    | THIRD        | PE                 | EC313       | Electronic Measurements                    | 3   | 0 | 0 | 3                                  |
|  |              |                    | EC315       | Introduction to Industrial Instrumentation | 3   | 0 | 0 | 3                                  |

| Monsoon  | LABORATORIES        |    |       |   |   |   |   |            |
|--|---------------------|----|-------|---|---|---|---|------------|
|  | THIRD               | PC | EC316 | Industrial Instrumentation Lab              | 0 | 0 | 4 | 2          |
| <b>TOTAL</b>   |                     |    |       |   |   |   |   | <b>8</b>   |
| SIXTH<br>Spring  | THIRD               | PE | EC359 | Microcontrollers and Interfacing            | 3 | 0 | 0 | 3          |
|  |                     |    | EC373 | Introduction to Sensors and Transducers     | 3 | 0 | 0 | 3          |
|  | <b>LABORATORIES</b> |    |       |   |   |   |   |            |
|  | THIRD               | PC | EC360 | Microcontroller Lab                         | 0 | 0 | 3 | 1.5        |
| <b>TOTAL</b>   |                     |    |       |   |   |   |   | <b>7.5</b> |
| SEVENTH<br>Monsoon   | FOURTH              | PE | EC421 | Bio-Medical Electronics & Signal Processing | 3 | 0 | 0 | 3          |
|  | <b>LABORATORIES</b> |    |       |   |   |   |   |            |
|  | FOURTH              | PC | EC422 | Bio-Medical Signal Processing Lab           | 0 | 0 | 3 | 1.5        |
| <b>TOTAL</b>   |                     |    |       |   |   |   |   | <b>4.5</b> |
| <b>GRAND TOTAL</b><br><i>Minimum requirement for In-depth Specialisation award</i> |                     |    |       |   |   |   |   | <b>20</b>  |

| <b>BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI</b><br><b>NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19</b><br><b>Based on CBCS &amp; OBE model</b><br><b>Recommended scheme of study for</b><br><b><i>In-depth Specialisation in Microwave Engineering</i></b> |                     |                    |             |   |   |   |   |                                    |
|--|---------------------|--------------------|-------------|---|---|---|---|------------------------------------|
| Semester/ Session of Study (Recommended)   | Course Level        | Category of course | Course Code | Courses                                       | Mode of delivery & credits<br><i>L-Lecture; T-Tutorial;P-Practicals</i> |   |   | Total Credits<br><i>C- Credits</i> |
|  |                     |                    |             |   | L   | T | P |                                    |
| <b>THEORY</b>  |                     |                    |             |   |   |   |   |                                    |
| FIFTH<br>Monsoon   | THIRD               | PE                 | EC323       | Microwave Theory and Techniques               | 3   | 0 | 0 | 3                                  |
|  |                     |                    | EC325       | Antenna and Wave Propagation                  | 3   | 0 | 0 | 3                                  |
|  | <b>LABORATORIES</b> |                    |             |   |   |   |   |                                    |
|  | THIRD               | PC                 | EC324       | Microwave Engineering Lab                     | 0   | 0 | 3 | 1.5                                |
| <b>TOTAL</b>   |                     |                    |             |   |   |   |   | <b>7.5</b>                         |
| SIXTH<br>Spring  | THIRD               | PE                 | EC365       | Radar and Navigation System                   | 3   | 0 | 0 | 3                                  |
|  |                     |                    | EC371       | Introduction to Electromagnetic Compatibility | 3   | 0 | 0 | 3                                  |
|  | <b>LABORATORIES</b> |                    |             |   |   |   |   |                                    |
|  | THIRD               | PC                 | EC366       | Advanced Microwave Lab                        | 0   | 0 | 3 | 1.5                                |

|  |                     |    |       |                            |   |   |   |            |
|--|---------------------|----|-------|----------------------------|---|---|---|------------|
| <b>TOTAL</b>   |                     |    |       |                            |   |   |   | <b>7.5</b> |
| SEVENTH<br>Monsoon   | FOURTH              | PE | EC419 | Satellite Communication    | 3 | 0 | 0 | 3          |
|  | <b>LABORATORIES</b> |    |       |                            |   |   |   |            |
|  | FOURTH              | PC | EC420 | Advanced Communication Lab | 0 | 0 | 4 | 2          |
| <b>TOTAL</b>   |                     |    |       |                            |   |   |   | <b>5</b>   |
| <b>GRAND TOTAL</b><br><i>Minimum requirement for In-depth Specialisation award</i> |                     |    |       |                            |   |   |   | <b>20</b>  |

**BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI**  
**NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19**  
**Based on CBCS & OBE model**  
**Recommended scheme of study for**  
***In-depth Specialisation in Wireless Communication and Networking***

| Semester/ Session<br>of Study<br>(Recommended)                                     | Course<br>Level     | Category<br>of course | Course<br>Code | Courses   | Mode of delivery & credits<br><i>L-Lecture; T-Tutorial;P-Practicals</i> |   |   | Total<br>Credits<br><i>C- Credits</i> |
|--|---------------------|-----------------------|----------------|---|---|---|---|---------------------------------------|
|  |                     |                       |                |   | L   | T | P |                                       |
| <b>THEORY</b>  |                     |                       |                |   |   |   |   |                                       |
| FIFTH<br>Monsoon   | THIRD               | PE                    | EC327          | Mobile and Cellular<br>Communication                    | 3   | 0 | 0 | 3                                     |
|  |                     |                       | EC329          | Information Theory and<br>Coding                        | 3   | 0 | 0 | 3                                     |
|  | <b>LABORATORIES</b> |                       |                |   |   |   |   |                                       |
|  | THIRD               | PC                    |                | Mobile and Cellular<br>EC328 0 0 3<br>Communication Lab |   |   |   | 1.5                                   |
| <b>TOTAL</b>   |                     |                       |                |   |   |   |   | <b>7.5</b>                            |
| SIXTH<br>Spring  | THIRD               | PE                    | EC367          | Computer Networking                                     | 3   | 0 | 0 | 3                                     |
|  |                     |                       | EC369          | Wireless Networks                                       | 3   | 0 | 0 | 3                                     |
|  | <b>LABORATORIES</b> |                       |                |   |   |   |   |                                       |
|  | THIRD               | PC                    | EC370          | Wireless Networks Lab                                   | 0   | 0 | 3 | 1.5                                   |
| <b>TOTAL</b>   |                     |                       |                |   |   |   |   | <b>7.5</b>                            |
| SEVENTH<br>Monsoon   | FOURTH              | PE                    | EC419          | Satellite Communication                                 | 3   | 0 | 0 | 3                                     |
|  | <b>LABORATORIES</b> |                       |                |   |   |   |   |                                       |
|  | FOURTH              | PC                    | EC420          | Advanced Communication<br>Lab                           | 0   | 0 | 4 | 2                                     |
| <b>TOTAL</b>   |                     |                       |                |   |   |   |   | <b>5</b>                              |
| <b>GRAND TOTAL</b><br><i>Minimum requirement for In-depth Specialisation award</i> |                     |                       |                |   |   |   |   | <b>20</b>                             |



**BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI**  
**NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19**  
**Based on CBCS & OBE model**  
**Recommended scheme of study for**  
***In-depth Specialisation in VLSI Systems***

| Semester/ Session of Study (Recommended)   | Course Level | Category of course | Course Code         | Courses                               | Mode of delivery & credits<br><i>L-Lecture; T-Tutorial; P-Practicals</i> |   |   | Total Credits<br><i>C- Credits</i> |
|--|--------------|--------------------|---------------------|---------------------------------------|--|---|---|------------------------------------|
|  |              |                    |                     |                                       | L  | T | P |                                    |
|  |              |                    |                     | <b>THEORY</b>                         |  |   |   |                                    |
| FIFTH Monsoon  | THIRD        | PE                 | EC319               | VLSI Systems                          | 3  | 0 | 0 | 3                                  |
|  |              |                    | EC321               | Microelectronic Devices and Circuits  | 3  | 0 | 0 | 3                                  |
|  |              |                    | <b>LABORATORIES</b> |                                       |  |   |   |                                    |
|  | THIRD        | PC                 | EC320               | VLSI Systems Lab                      | 0  | 0 | 3 | 1.5                                |
| <b>TOTAL</b>   |              |                    |                     |                                       |  |   |   | <b>7.5</b>                         |
| SIXTH Spring   | THIRD        | PE                 | EC361               | Digital Systems Design with FPGAs     | 3  | 0 | 0 | 3                                  |
|  |              |                    | EC363               | Nanoelectronics                       | 3  | 0 | 0 | 3                                  |
|  |              |                    | <b>LABORATORIES</b> |                                       |  |   |   |                                    |
|  | THIRD        | PC                 | EC362               | Digital Systems Design with FPGAs Lab | 0  | 0 | 4 | 2                                  |
| <b>TOTAL</b>   |              |                    |                     |                                       |  |   |   | <b>8</b>                           |
| SEVENTH Monsoon  | FOURTH       | PE                 | EC413               | Real Time Embedded System             | 3  | 0 | 0 | 3                                  |
|  |              |                    | <b>LABORATORIES</b> |                                       |  |   |   |                                    |
|  | FOURTH       | PC                 | EC414               | Real Time Embedded System Lab         | 0  | 0 | 3 | 1.5                                |
| <b>TOTAL</b>   |              |                    |                     |                                       |  |   |   | <b>4.5</b>                         |
| <b>GRAND TOTAL</b><br><i>Minimum requirement for In-depth Specialisation award</i> |              |                    |                     |                                       |  |   |   | <b>20</b>                          |

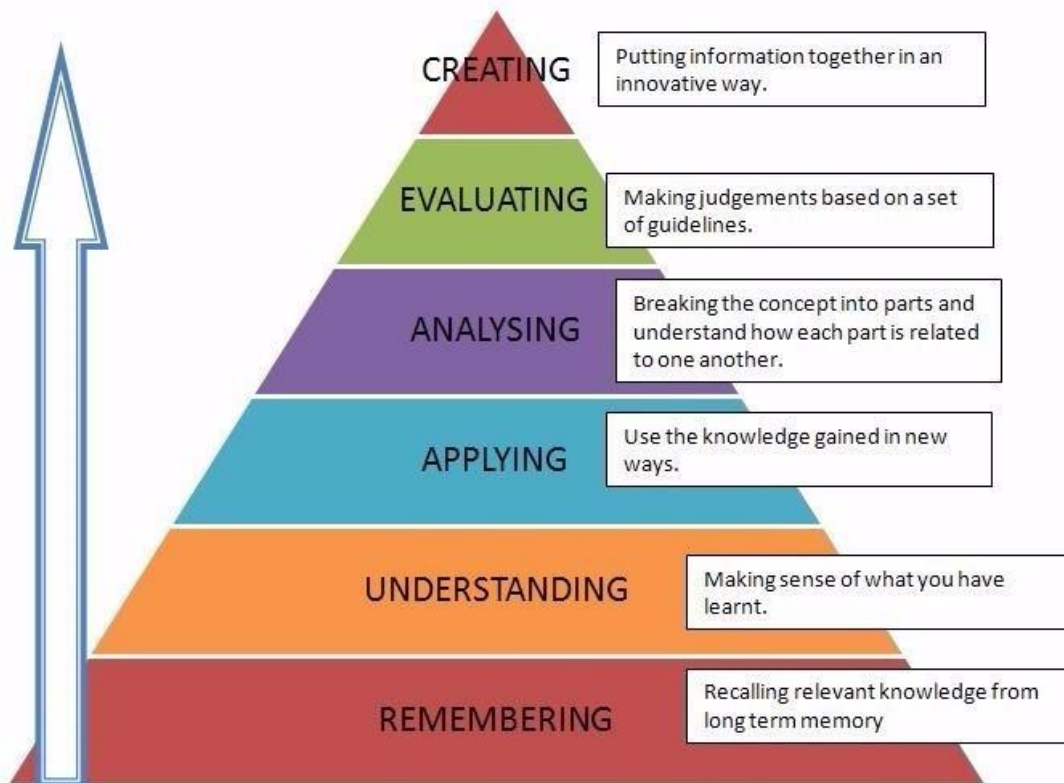
**BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI**  
**NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19**  
**Based on CBCS & OBE model**  
**Recommended scheme of study for**  
**Minor in Electronics & Communications Engineering**

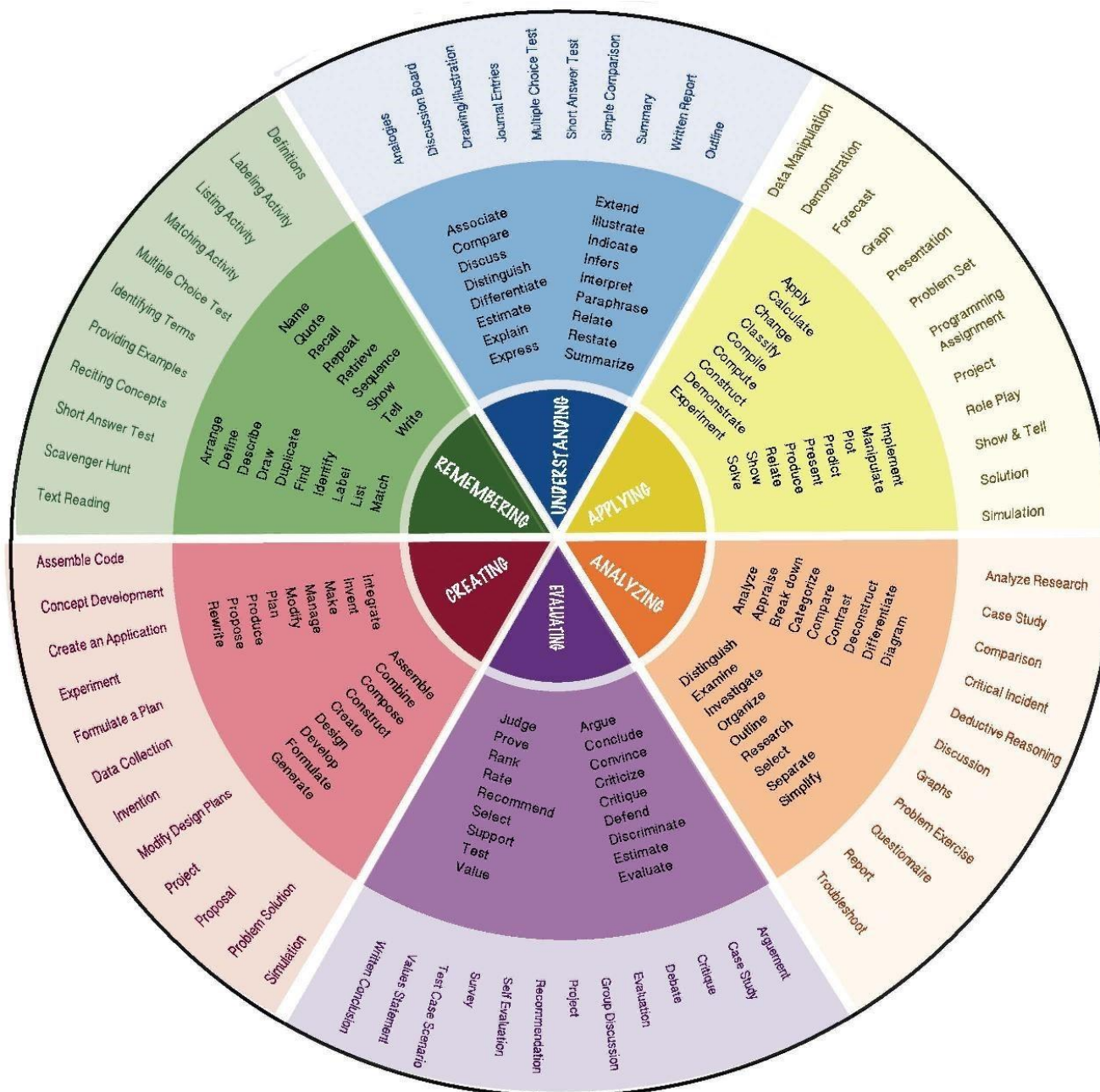
| Semester/ Session of Study (Recommended)          | Course Level | Category of course  | Course Code     | Course   | Mode of delivery & credits L- Lecture; T-Tutorial;P-Practicals |   |   | Total Credits C- Credits |
|---|--------------|---------------------|-----------------|--|--|---|---|--------------------------|
|   |              |                     |                 |  | L  | T | P | C                        |
|   |              | <b>THEORY</b>       |                 |  |  |   |   |                          |
| FIFTH Monsoon                                     | SECOND       | PC                  | EC201/<br>EC203 | Electronic Devices/<br>Digital System Design         | 3  | 0 | 0 | 3                        |
|   |              |                     | EC205           | Signals and Systems                                  | 3  | 0 | 0 | 3                        |
|   |              | <b>LABORATORIES</b> |                 |  |  |   |   |                          |
|   | SECOND       | PC                  | EC202/<br>EC204 | Electronic Devices Lab/<br>Digital System Design Lab | 0  | 0 | 3 | 1.5                      |
| <b>TOTAL</b>                                      |              |                     |                 |  |  |   |   | <b>7.5</b>               |
| SIXTH Spring                                      | SECOND       | PC                  | EC253           | Analog Circuits                                      | 3  | 0 | 0 | 3                        |
|   |              |                     | EC255           | Analog Communication                                 | 3  | 0 | 0 | 3                        |
|   |              | <b>LABORATORIES</b> |                 |  |  |   |   |                          |
|   | SECOND       | PC                  | EC254           | Analog Circuits Lab                                  | 0  | 0 | 3 | 1.5                      |
| <b>TOTAL</b>                                      |              |                     |                 |  |  |   |   | <b>7.5</b>               |
| SEVENTH Monsoon                                   | THIRD        | PC                  | EC301           | Digital Communication                                | 3  | 0 | 0 | 3                        |
|   |              | <b>LABORATORIES</b> |                 |  |  |   |   |                          |
|   | FOURTH       | PC                  | EC402           | Communication Lab                                    | 0  | 0 | 3 | 2                        |
| <b>TOTAL</b>                                      |              |                     |                 |  |  |   |   | <b>5</b>                 |
| <b>GRAND TOTAL</b>                                |              |                     |                 |  |  |   |   | <b>20</b>                |
| <i>Minimum requirement for Minor degree award</i> |              |                     |                 |  |  |   |   |                          |

## BLOOM'S TAXONOMY FOR CURRICULUM DESIGN AND ASSESSMENT:

### *Preamble*

The design of curriculum and assessment is based on Bloom's Taxonomy. A comprehensive guideline for using Bloom's Taxonomy is given below for reference.







## COURSE INFORMATION SHEET

**Course code:** EC101

**Course title:** Basics of Electronics & Communication Engineering

**Pre-requisite(s):** N/A

**Co- requisite(s):** N/A

**Credits:** L: 3 T: 1 P: 0 C: 4 **Class**

**schedule per week: 04 Class: B. Tech.**

**Semester / Level: 01/01 Branch: ALL**

**B. Tech.**

**Name of Teacher: All**

### Course Objectives:

This course enables the students:

|    |   |
|----|---|
| 1. | To understand PN Junction, diodes and their applications.                           |
| 2. | To comprehend BJT, FET and their bias configurations.                               |
| 3. | To grasp importance of feedback in amplifier circuits, op amp and its applications. |
| 4. | To understand number system, Logic Gates and Boolean algebra.                       |
| 5. | To apprehend fundamentals of communication technology.                              |

### Course Outcomes:

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Explain PN Junction, diodes and their applications.  |
| CO2 | Appraise the BJT, FET and their biasing techniques.  |
| CO3 | Comprehend feedback in amplifier circuits, op amp and its applications.  |
| CO4 | Translate one number system into another, build circuits with Logic Gates, electronic components and OPAMP IC 741 and analyze the measurement results using CRO. |
| CO5 | Appraise the fundamentals of communication technology.   |

## SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <p><b><u>Module-1</u></b><br/>           Diodes and Applications: Introduction to PN junction diodes; Characteristics of semiconductor diodes: V-I characteristics, diode-resistance, temperature dependence, diode-capacitance; DC &amp; AC load lines; Breakdown Mechanisms; Zener Diode – Operation and Applications; Diode as a Rectifier: Half Wave and Full Wave Rectifiers with and without C-Filters.</p>  | <b>12</b>              |
| <p><b><u>Module-2</u></b><br/> <b>Bipolar Junction Transistors (BJT):</b> PNP and NPN Transistors, Basic Transistor Action, Input and Output Characteristics of CB, CE and CC Configurations, dc and ac load line analysis, operating point, Transistor biasing: Fixed bias, emitter bias/self-bias, Low-frequency response of CE amplifier.<br/> <b>Field Effect Transistors:</b> JFET, Idea of Channel Formation, Pinch-Off and saturation Voltage, Current-Voltage Output Characteristics; MOSFET: Basic structure, operation and characteristics.</p>  | <b>12</b>              |
| <p><b><u>Module-3</u></b><br/> <b>Sinusoidal Oscillators:</b> Concept of positive and negative feedback, Barkhausen criterion for sustained oscillations, Determination of Frequency and Condition of oscillation, Hartley and Colpitt's oscillator.<br/> <b>Operational Amplifiers:</b> Characteristics of an Ideal and Practical Operational Amplifier (IC 741), Inverting and non-inverting amplifiers, Offset error voltages and currents; Power supply rejection ratio, Slew Rate and concept of Virtual Ground, Summing and Difference Amplifiers, Differentiator and Integrator, RC phase shift oscillator.</p> | <b>8</b>               |
| <p><b><u>Module-4</u></b><br/> <b>Logic Gates and Boolean algebra:</b> Introduction to Boolean Algebra and Boolean operators, Symbolic representation, Boolean algebraic function and Truth table of different Digital logic Gates (AND, OR, NOT, NAND, NOR, EXOR, EX-NOR); Realization of Basic logic gates using universal gates, Adder, Subtractor, adder/subtractor.</p>   | <b>8</b>               |

|   |                  |
|---|------------------|
| <p><b>Module-5</b><br/> <b>Electronic communication:</b> Introduction to electronic communication system, Electromagnetic Communication spectrum band and applications, Elements of Electronic Communication System; Merits and demerits of analog and digital communication, Modes of communication; Signal radiation and propagation; Need for modulation; Introduction to Amplitude modulation and Angle modulation.</p> | <p><b>10</b></p> |
|---|------------------|

**Text Books:**

1. Millman J., Halkias C.C., Parikh Chetan, “Integrated Electronics: Analog and Digital Circuits and Systems”, Tata McGraw-Hill, 2/e.
2. Mano M.M., “Digital Logic and Computer Design”, Pearson Education, Inc, Thirteenth Impression, 2011.
3. Singal T. L., “Analog and Digital Communications”, Tata McGraw-Hill, 2/e.
4. Haykin S., Moher M., “Introduction to Analog & Digital Communications”, Wiley India Pvt. Ltd., 2/e.

**Reference Book:**

1. Boylstead R.L., Nashelsky L., “Electronic Devices and Circuit Theory”, Pearson Education, Inc, 10/e.

**Gaps in the syllabus (to meet Industry/Profession requirements): NA**

**POs met through Gaps in the Syllabus: 3, 11, 12**

**Topics beyond syllabus/Advanced topics/Design: NA**

**POs met through Topics beyond syllabus/Advanced topics/Design: 2, 3, 11, 12**

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher’s Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**



1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

### Mapping of Course Outcomes onto Program Outcomes:

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 1 | 2 | 3 | 1 | 1 | 2 | 2 | 3  | 2  | 2  | 3                                | 3  | 1  |
| CO2            | 3                      | 3 | 1 | 2 | 3 | 1 | 1 | 2 | 2 | 3  | 2  | 2  | 3                                | 3  | 1  |
| CO3            | 3                      | 3 | 1 | 2 | 3 | 1 | 1 | 2 | 2 | 3  | 2  | 2  | 3                                | 3  | 1  |
| CO4            | 3                      | 3 | 1 | 2 | 3 | 1 | 1 | 2 | 2 | 3  | 2  | 2  | 3                                | 3  | 1  |
| CO5            | 3                      | 3 | 1 | 2 | 3 | 1 | 1 | 2 | 2 | 3  | 2  | 2  | 3                                | 3  | 1  |

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD2, CD3, CD8          |
| CD2     | Quizzes   | CO2            | CD1, CD2, CD3, CD8          |
| CD3     | Assignments/Seminars  | CO3            | CD1, CD2, CD3, CD8          |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1, CD2, CD3, CD8          |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD1, CD2, CD3, CD8          |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9     | Simulation  |                |                             |

## COURSE INFORMATION SHEET

**Course code:** EC102

**Course title:** Electronics & Communication Lab **Pre-requisite(s):**

**Co- requisite(s):**

**Credits:** L: 0 T: 0 P: 3 C: 1.5

**Class schedule per week: 03 Class: B.**

**Tech. Semester / Level: 01/01 Branch:**

**ALL B. Tech.**

**Name of Teacher: ALL**

### Course Objectives:

This course enables the students:

|    |  |
|----|--|
| 1. | To demonstrate the measurement of voltage, frequency using CRO   |
| 2. | To explain PN junction characteristics and its applications.     |
| 3. | To understand the frequency response of BJT amplifier and OPAMP. |
| 4. | To Realize logic gates and implement simple Boolean expression.  |
| 5. | To explain the Amplitude Modulation and Frequency Modulation     |

### Course Outcomes:

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Make use of CRO for measuring different parameters                          |
| CO2 | Appraise PN junction characteristics and its applications.                  |
| CO3 | Experiment with Diodes, BJT and OPAMP                                       |
| CO4 | Design specified circuit using given electronic components/ICs/logic gates. |
| CO5 | Demonstrate the working of Amplitude Modulation and Frequency Modulation    |

## Syllabus

### List of Compulsory experiments:

1. **Name of the Experiment: MEASUREMENTS USING CRO**

AIM-1: To understand the Measurement of voltage, time period and frequency of different signals on CRO.

AIM-2: To measure the frequency and phase of two different signals using Lissajous pattern.

2. **Name of the Experiment: PN JUNCTION CHARACTERISTICS**

AIM-1: To determine the forward bias V-I characteristics of PN junction diode and finding its forward cut-in voltage.

AIM-2: To determine the reverse bias V-I characteristics of PN junction diode and finding its reverse breakdown voltage.

3. **Name of the Experiment: ZENER DIODE**

AIM-1: To design a basic voltage regulator circuit using Zener diode.

AIM-2: To determine the reverse bias V-I characteristics of Zener diode and finding its reverse breakdown voltage.

4. **Name of the Experiment: RECTIFIERS WITH FILTERS.**

AIM-1: To understand the basic operation principle of Half-wave rectifier circuit and measurement of rectification efficiency and ripple factor with and without C-Filter.

AIM-2: To understand the basic operation principle of Full-wave rectifier circuit and measurement of rectification efficiency and ripple factor with and without C-Filter.

AIM-3: Simulate Half wave, Full wave and Bridge rectifier circuits and determine the following in each case

- i) ripple factor
- ii) ratio of rectification
- iii) TUF.

AIM-4: Simulate Half wave rectifier circuit and observe the effect on rectification at high frequency.

5. **Name of the Experiment: CE TRANSISTOR AMPLIFIER**

AIM-1: To understand the basic operation principle of CE transistor amplifier circuit and finding its frequency response.

AIM-2: To determine the gain bandwidth product of CE transistor amplifier from its frequency response.

AIM-3: To determine the minimum input voltage for which the CE transistor amplifier saturates for given gain.

6. **Name of the Experiment: FIELD EFFECT TRANSISTOR**

AIM-1: To determine the output and transfer characteristics of JFET.

AIM-2: To measure the voltage gain of JFET.

7. **Name of the Experiment: RC OSCILLATOR.**

AIM-1: To design a RC phase shift oscillator using IC-741 Op-Amp.

AIM-2: To measure its frequency of oscillation and finding the percentage of error in Comparison with the ideal one.

8. **Name of the Experiment: OPERATIONAL AMPLIFIERS**

AIM-1: To design the Inverting and Non-inverting amplifier using IC 741 OP-AMP.

AIM-2: To find its frequency response and calculate the gain bandwidth product.

AIM-3: To determine the minimum input voltage for which the inverting and non-inverting amplifier saturates for the gains 100 and 101 respectively.

9. **Name of the Experiment: LOGIC GATES**

AIM-1: To understand basic Boolean logic functions (NOT, AND, OR).

AIM-2: To realize the basic logic gates (AND, OR, NOT) using NAND Gate (IC-7400).

10. **Name of the Experiment: BOOLEAN FUNCTION**

AIM-1: To understand AND Gate IC (IC 7408) and OR Gate IC (IC 7432)

AIM-2: To implement of the Boolean expression  $F = (A.B.C + D.E)$  using AND Gate (IC 7408) and OR Gate (IC 7432).

11. **Name of the Experiment: AMPLITUDE MODULATION**

AIM-1: To analyze the Amplitude modulation for three different cases (under modulation, critical modulation and over modulation) using standard setup.

AIM-2: To determine the percentage of error between the ideal and actual observations.

12. **Name of the Experiment: FREQUENCY MODULATION**

AIM-1: To analyze the Frequency modulation using standard setup.

AIM-2: To determine the value of frequency deviation from the observation.

**Text Books:**

1. Millman J., Halkias C.C., Parikh Chetan, “Integrated Electronics: Analog and Digital Circuits and Systems”, Tata McGraw-Hill, 2/e.
2. Mano M.M., “Digital Logic and Computer Design”, Pearson Education, Inc, Thirteenth Impression, 2011.
3. Singal T. L., “Analog and Digital Communications”, Tata McGraw-Hill, 2/e.
4. Haykin S., Moher M., “Introduction to Analog & Digital Communications”, Wiley India Pvt. Ltd., 2/e.

**Reference Book:**

1. Boylstead R.L., Nashelsky L., “Electronic Devices and Circuit Theory”, Pearson Education, Inc, 10/e.

**Gaps in the syllabus (to meet Industry/Profession requirements): NA**

**POs met through Gaps in the Syllabus: N/A.**

**Topics beyond syllabus/Advanced topics/Design: N/A**

**POs met through Topics beyond syllabus/Advanced topics/Design: N/A**

**Course Outcome (CO) Attainment Assessment tools & Evaluation procedure**

**Direct Assessment**

| Assessment Tool               | % Contribution during CO Assessment |
|-------------------------------|-------------------------------------|
| <b>Progressive Evaluation</b> | <b>(60)</b>                         |
| Attendance Marks              | <b>12</b>                           |
| Day-to-day performance Marks  | <b>06</b>                           |
| Lab Viva marks                | <b>20</b>                           |
| Lab file Marks                | <b>12</b>                           |
| Lab Quiz-I Marks              | <b>10</b>                           |
| <b>End SEM Evaluation</b>     | <b>(40)</b>                         |
| Lab Quiz-II Marks             | <b>10</b>                           |
| Lab performance Marks         | <b>30</b>                           |

**Indirect Assessment –**

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

## Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |   |   |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|---|---|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1                                | 2 | 3 |
| CO1            | 3                      | 3 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 2  | 2  | 2  | 2                                | 2 | 1 |
| CO2            | 3                      | 3 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 2  | 2  | 2  | 2                                | 2 | 1 |
| CO3            | 3                      | 2 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 2  | 2  | 2  | 2                                | 2 | 1 |
| CO4            | 3                      | 3 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 2  | 2  | 2  | 2                                | 2 | 1 |
| CO5            | 3                      | 2 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 2  | 2  | 2  | 2                                | 2 | 1 |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods:

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD5, CD9               |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1, CD5, CD9               |
| CD3     | Seminars/ Quiz (s)  | CO3            | CD1, CD5, CD9               |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1, CD5, CD9               |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD1, CD5, CD9               |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |

|     |            |  |  |
|-----|------------|--|--|
| CD9 | Simulation |  |  |
|-----|------------|--|--|

### COURSE INFORMATION SHEET

**Course code: EC201**

**Course title: Electronic Devices**

**Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering Co-requisite(s):**

**Credits: L: 3 T: 0 P: 0 C: 3 Class**

**schedule per week: 03 Class: B. Tech.**

**Semester / Level: III/02**

**Branch: ECE**

**Name of Teacher:**

#### **Course Objectives**

This course envisions to impact to students to:

|    |  |
|----|--|
| 1. | Understand Atoms, Electrons, Energy Bands and Charge Carriers in Semiconductors.   |
| 2. | Grasp the impact of Excess Carriers in Semiconductors, Optical Absorption, Carrier Lifetime, Photoconductivity and Diffusion of Carriers and apply the obtained knowledge. |

|    |   |
|----|---|
| 3. | Appraise and analyse the characteristics of PN Junction and Junction Diodes.            |
| 4. | Evaluate the characteristics of Bipolar Junction Transistor (BJT).                      |
| 5. | Comprehend the characteristics of Field-Effect Transistors and create their structures. |

### Course Outcomes

After the completion of this course, a student will be able to:

|     |  |
|-----|--|
| CO1 | Describe and illustrate the Atoms, Electrons, Energy Bands and Charge Carriers in Semiconductors.                              |
| CO2 | Sketch and explain the Carrier Transport Phenomena in semiconductor.   |
| CO3 | Illustrate with the sketch of the structure of PN Junction and Junction Diodes diagram their characteristics and analyse them. |
| CO4 | Appraise the principle of operation BJTs, schematize their characteristics, assess and summarize their features.               |
| CO5 | Schematize the structure and design Field Effect Transistors. Schematize their characteristics and prepare an inference.       |

### SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <b>Module – I</b><br><b>Atoms, Electrons, Energy Bands and Charge Carriers in Semiconductors:</b><br>Quantum Mechanics, Bonding Forces and Energy Bands in Solids, Direct and Indirect Semiconductors, <b>LED</b> , Variation of Energy Bands with Alloy Composition, Effective Mass, Electrons and Holes in Quantum Wells, <b>Gunn Diode</b> , Temperature Dependence of Carrier Concentrations, Conductivity and Mobility, High-Field Effects, The Hall Effect. | <b>8</b>               |



|   |          |
|---|----------|
| <p><b>Module – II</b><br/> <b>Excess Carriers in Semiconductors:</b><br/> Optical Absorption, Luminescence, Carrier Lifetime and Photoconductivity, Solar Cells; Diffusion of Carriers: Diffusion Processes, Diffusion and Drift of Carriers; Built-in Fields, Diffusion and Recombination; The Continuity Equation, Steady State Carrier Injection; Diffusion Length, The Haynes–Shockley Experiment.</p>                              | <b>8</b> |
| <p><b>Module – III</b><br/> <b>PN Junction and Junction Diodes:</b><br/> Charge at Junction, Contact Potential, Capacitance of p-n Junctions, Reverse-Bias Breakdown, <b>Zener diode, Varactor Diode</b>, Effects of Contact Potential on Carrier Injection, Recombination and Generation in Transition Region, Metal–Semiconductor Junctions, PIN diodes, Step Recovery Diodes, IMPATT diodes, Tunnel Diode.</p>                       | <b>8</b> |
| <p><b>Module – IV</b><br/> <b>Bipolar Junction Transistor (BJT):</b><br/> Fundamentals of BJT Operation, Amplification with BJTs, Minority Carrier Distributions and Terminal Currents, Drift in the Base Region, Base Narrowing, Avalanche Breakdown, Gummel–Poon Model, Kirk Effect; Frequency Limitations of Transistors, High-Frequency Transistors, Heterojunction Bipolar Transistors.</p>  | <b>8</b> |
| <p><b>Module – V</b><br/> <b>Field-Effect Transistors:</b><br/> Junction FET, GaAs MESFET, High Electron Mobility Transistor (HEMT); Metal–Insulator–Semiconductor FET, MOSFET: Output Characteristics, Transfer Characteristics, Mobility Models, Short Channel MOSFET I–V Characteristics, Threshold Voltage Expression, Substrate Bias Effects, Subthreshold Characteristics, Equivalent Circuit for the MOSFET, CMOS processes.</p> | <b>8</b> |

**Textbooks:**

1. G. Streetman, and S. K. Banerjee, “Solid State Electronic Devices,” 7th edition, Pearson, 2014.
2. J. P. Colinge, C. A. Colinge, “Physics of Semiconductor Devices”, Springer Science & Business Media, 2007.

**Reference books:**

1. SM Sze, Kwok K. Ng, “Physics of Semiconductor Devices”, 3/e, Wiley-Interscience, 2006.
2. Donald A. Neamen, Dhruves Biswas "Semiconductor Physics and Devices", 4/e, McGrawHill Education, 2012.

**Gaps in the syllabus (to meet Industry/Profession requirements):**

1. Hands-on-practical for Device fabrication.

**POs met through Gaps in the Syllabus:**

10

**Topics beyond syllabus/Advanced topics/Design:**

1. N/A

**POs met through Topics beyond syllabus/Advanced topics/Design:**

10

**Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping between Course Outcomes and Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO2            | 3                      | 3 | 2 | 3 | 3 | 2 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO3            | 3                      | 3 | 2 | 3 | 3 | 2 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO4            | 3                      | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO5            | 3                      | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD7, CD 8              |
| CD2     | Tutorials/Assignments                   | CO2            | CD1 and CD9                 |
| CD3     | Seminars                                | CO3            | CD1, CD2 and CD3            |

|     |   |     |             |
|-----|---|-----|-------------|
| CD4 | Mini Projects/Projects                                      | CO4 | CD1 and CD2 |
| CD5 | Laboratory Experiments/Teaching Aids                        | CO5 | CD1 and CD2 |
| CD6 | Industrial/Guest Lectures                                   |     |             |
| CD7 | Industrial Visits/In-plant Training                         |     |             |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |     |             |
| CD9 | Simulation  |     |             |

### **COURSE INFORMATION SHEET**

**Course code: EC202**

**Course title: Electronics Device Lab**

**Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering,**

**Co- requisite(s): EC201 Electronic Devices**

**Credits: L: 0 T: 0 P: 3 C:**  
**1.5 Class periods per week: 03 Class: B.**  
 Tech.  
**Semester / Level: III/02**  
**Branch: ECE Name**  
**of Teacher:**

**Course Objectives**

This course enables the students to:

|    |  |
|----|--|
| 1. | understand the material and electrical parameters of intrinsic and extrinsic semiconductor materials.  |
| 2. | understand the basic characteristics of MOS transistor, Tunnel diode and solar cell  |
| 3. | apply their understanding to use advance design TCAD tool to obtain the material and electrical parameters of intrinsic and extrinsic semiconductor materials. |
| 4. | apply their understanding to use advance design TCAD tool to describe basic characteristics of BJT and MOS transistors and inverter.                           |
| 5. | apply their understanding to use advance design TCAD tool to analyze characteristics of inverter.  |

**Course Outcomes**

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | analyse the material and electrical parameters of intrinsic and extrinsic semiconductor materials.                                      |
| CO2 | measure the basic characteristics of Tunnel diode and solar cell  |
| CO3 | measure the basic characteristics of MOS transistors  |
| CO4 | use the advance design tool TCAD to evaluate the material and electrical parameters of intrinsic and extrinsic semiconductor materials. |
| CO5 | use the advance design tool TCAD to construct BJT, MOS transistors and inverter and evaluate their characteristics.                     |

**SYLLABUS**

Lab is the application of the theory (i.e., hands-on experiments related to the course contents). Therefore, **EC201 Electronic Devices** is the syllabus for the **EC202 Electronic Devices Lab**. Following experiments are the guidelines for the students. However, the questions for exams are not limited to this experiment list.

**List of Compulsory experiments:**

1. Identify the type of semiconductor material and calculate the mobility, conductivity and carrier concentration of majority carriers using Hall Effect experiment.
2. Calculate the bandgap of semiconductor materials.
3. Measure the I-V characteristics of an NPN transistor in Common Emitter (CE) mode.
4. Measure the  $I_d$ - $V_d$  and  $I_d$ - $V_g$  characteristics of an enhancement mode nMOSFET and a depletion mode nMOSFET.
5. Measure the I-V characteristics of a tunnel diode.
6. Evaluate the I-V characteristics of an illuminated pn junction (solar cell).
7. Evaluate the parameters (sheet resistance, mobility, saturation velocity, etc.) of the intrinsic and the extrinsic semiconductor materials using TCAD tool.
8. Construct a silicon pn junction diode and evaluate I-V characteristics curve using TCAD tool.
9. Develop an NPN Transistor and measure the I-V characteristics curves in Common Emitter (CE) mode using TCAD tool.
10. Develop an enhancement mode nMOSFET and measure  $I_d$ - $V_d$  and  $I_d$ - $V_g$  characteristics using TCAD tool.
11. Construct an enhancement mode pMOSFET and measure  $I_d$ - $V_d$  and  $I_d$ - $V_g$  characteristics using TCAD tool.
12. Design a CMOS inverter and asses the DC/transient characteristics using TCAD tool.

**List of Optional experiments:**

1. Calculate the mobility and the diffusion coefficient of minority carriers using Haynes Shockley experiment.
2. Evaluate the I-V characteristics of an NPN transistor in Common Collector (CC) mode.
3. Measure the I-V characteristics of an NPN transistor in Common Base (CB) mode.
4. Evaluate the I-V characteristics of a PNP transistor in Common Emitter (CE) mode.
5. Measure the I-V characteristics of a PNP transistor in Common Collector (CC) mode.
6. Evaluate the I-V characteristics of a PNP transistor in Common Base (CB) mode.

7. Demonstrate the I-V characteristics of forward and reverse biased Silicon and Germanium pn-junction diode.
8. Demonstrate the I-V characteristics of forward and reverse biased Zener diode. Study the breakdown characteristics of the Zener diode.
9. Construct a PNP Transistor and evaluate the I-V characteristics curves in Common Emitter (CE) mode using TCAD tool.
10. Demonstrate diode application as a rectifier using TCAD tool
11. Construct a depletion mode nMOSFET and evaluate Id-Vd and Id-Vg characteristics using TCAD tool.
12. Construct a depletion mode pMOSFET and evaluate Id-Vd and Id-Vg characteristics using TCAD tool.

**Books recommended:**

**Textbooks:**

1. G. Streetman, and S. K. Banerjee, "Solid State Electronic Devices," 7th edition, Pearson, 2014.
2. J. P. Colinge, C. A. Colinge, "Physics of Semiconductor Devices", Springer Science & Business Media, 2007.
3. J. Rabaey, A. Chandrakasan, B. Nikolic, "Digital Integrated Circuits: A Design Perspective", 2nd ed., Prentice Hall, 2003.

**Reference books:**

1. SM Sze, Kwok K. Ng, "Physics of Semiconductor Devices", 3/e, Wiley-Interscience, 2006.
2. Donald A. Neamen, Dhruves Biswas "Semiconductor Physics and Devices", 4/e, McGraw-Hill Education, 2012.
3. Cogenda Visual TCAD tool user manual.

**Gaps in the syllabus (to meet Industry/Profession requirements):**

1. Hands-on-practical for Device fabrication.

**POs met through Gaps in the Syllabus:**

10

**Topics beyond syllabus/Advanced topics/Design:**

N/A

**POs met through Topics beyond syllabus/Advanced topics/Design:**

10

## Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

### Direct Assessment

| Assessment Tools               | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | 60                                  |
| Semester End Examination       | 40                                  |

| Continuous Internal Assessment     | % Distribution |
|------------------------------------|----------------|
| Day to day performance & Lab files | 30             |
| Quiz(zes)                          | 10             |
| Viva                               | 20             |

| Semester End Examination           | % Distribution |
|------------------------------------|----------------|
| Examination Experiment Performance | 30             |
| Quiz                               | 10             |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 3                                | 2  | 2  |
| CO2            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 3                                | 2  | 2  |
| CO3            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO4            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO5            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 3                                | 2  | 1  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Course Delivery Methods

|     |   |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors      |
| CD2 | Assignments   |
| CD3 | Laboratory experiments/Teaching aids/Seminars               |
| CD4 | Mini Projects   |
| CD5 | Industrial visits/in-plant training                         |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation  |

### Mapping between Course Outcomes and Course Delivery Method

| Course Outcomes | Course Delivery Method |
|-----------------|------------------------|
| CO1             | CD1, CD3, CD6, CD7     |
| CO2             | CD1, CD3, CD6, CD7     |
| CO3             | CD1, CD3, CD6, CD7     |
| CO4             | CD1, CD3, CD6, CD7     |
| CO5             | CD1, CD3, CD6, CD7     |



## **COURSE INFORMATION SHEET**

**Course code:** EC203

**Course title:** Digital System Design

**Pre-requisite(s):** EC101 Basics of Electronics & Communication Engineering **Co-requisite(s):**

**Credits:**        **L: 3    T:0    P:0    C:3**

**Class schedule per week:** 3x1

**Class:** B. Tech

**Semester / Level:** III/02

**Branch:** ECE Name

**of Teacher:**

### **Course Objectives**

This course enables the students to:

|    |   |
|----|---|
| 1. | Understand the basics of digital electronics.                                     |
| 2. | Apply the knowledge of digital electronics to construct various digital circuits. |
| 3. | Analyze the characteristics and explain the outputs of digital circuits.          |
| 4. | Evaluate and assess the application of the digital circuits.                      |
| 5. | Design digital machine for simple computing and control.                          |

### **Course Outcomes**

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Explain the concept of digital electronics.                  |
| CO2 | Apply the knowledge to produce digital electronics circuits. |
| CO3 | Analyse and categorize digital circuits.                     |
| CO4 | Justify the uses of different digital circuits.              |
| CO5 | Schematize and demonstrate simple computing machines.        |

## SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b></p> <p>Basics of Digital Electronics: Number representation, Binary number system, Number base conversion, Octal, Hexadecimal and BCD codes, Binary Arithmetic, Logic gates, Introduction to VHDL and Verilog, VHDL Models, Logic Families: TTL, ECL, and CMOS Logic Circuits, Logic levels, voltages and currents, fan-in, fan-out, speed, power dissipation. Comparison of logic families.</p> | <p><b>8</b></p>        |
| <p><b>Module – II</b></p> <p>Simplification of Boolean functions: Boolean Algebra, Basic theorems and Properties, De Morgan’s theorem, Canonical &amp; Standard forms, Simplification of a Boolean function using Karnaugh map, POS &amp; SOP simplification, Prime implicant, NAND and NOR implementation.</p>   | <p><b>8</b></p>        |
| <p><b>Module – III</b></p> <p><b>Design of Combinational Circuits:</b> Analysis and design procedure, Parity Generators and Checkers, Adders, Subtractors, Look ahead carry, Adder, 4-bit BCD adder/subtractor, Magnitude comparator, Decoders, Encoders, Multiplexers, De-multiplexers, Design of 1 bit ALU for basic logic and arithmetic operations.</p>   | <p><b>8</b></p>        |
| <p><b>Module – IV</b></p> <p><b>Design of Sequential Circuits and Memories:</b> Basic Latch, Flip-Flops (SR, D, JK, T and Master-Slave), Triggering of Flip Flops, Synchronous and asynchronous counters, Registers, Shift Registers, Memories and Programmable Logic design, Types of memories, Memory Expansion and its decoding, Programmable Logic Arrays (PLA), Programmable Array Logic (PAL)</p>               | <p><b>8</b></p>        |

|   |          |
|---|----------|
| <b>Module – V</b><br><br><b>Design of simple computing machines:</b> SAP-I concepts with stress on timing diagrams, Microinstructions, Fetch and Execution cycle variable machine cycle, Hardware control Matrix, Macroinstructions, Microprogramming, Bus concepts, Multiplexed Minimum system. Pipelining concepts. | <b>8</b> |
|---|----------|

**Books recommended:**

**Textbooks:**

1. “Digital Design”, Morris Mano and Michael D. Ciletti ,5<sup>th</sup> edition PHI
2. “Digital System Design using VHDL”, Charles H Roth, Thomson Learning **Reference**

**books:**

1. Digital computer Electronics AP Malvino, 3rd Edition Mc Graw Hill

**Gaps in the syllabus (to meet Industry/Profession requirements): N/A**

**POs met through Gaps in the Syllabus: N/A**

**Topics beyond syllabus/Advanced topics/Design: Computer System Architecture**

**POs met through Topics beyond syllabus/Advanced topics/Design: N/A**

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher’s Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students’ Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| <b>CO1</b>     | 3                      | 3 | 2 | 3 | 3 | 1 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 2  |
| <b>CO2</b>     | 3                      | 3 | 2 | 3 | 3 | 3 | 2 |   |   | 3  |    | 3  | 3                                | 3  | 2  |
| <b>CO3</b>     | 3                      | 3 | 2 | 3 | 3 | 3 | 2 |   |   | 3  |    | 3  | 3                                | 3  | 2  |
| <b>CO4</b>     | 3                      | 3 | 2 | 3 | 3 | 2 | 2 |   |   | 3  |    | 3  | 3                                | 3  | 2  |
| <b>CO5</b>     | 3                      | 3 | 2 | 3 | 3 | 2 | 2 |   |   | 3  |    | 3  | 3                                | 3  | 2  |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD2, CD5, CD 8         |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1, CD2, CD5, CD 8         |
| CD3     | Seminars  | CO3            | CD1, CD2, CD5, CD 8         |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1, CD2, CD5, CD 8         |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD1, CD2, CD5, CD 8         |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9     | Simulation  |                |                             |

## COURSE INFORMATION SHEET

**Course code: EC204**

**Course title: Digital System design Lab**

**Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering Co-requisite(s):**

**Credits: L:0 T:0 P:3 C:1.5**

**Class schedule per week: 03**

**Class: B. Tech**

**Semester / Level: III/ 02**

**Branch: ECE Name  
of Teacher:**

### Course Objectives

This course enables the students to:

|    |  |
|----|--|
| 1. | Understand the basics of logic gates, input, output, power supply, and gates IC's.             |
| 2. | Apply the knowledge of digital electronics to construct combinational and sequential circuits. |
| 3. | Analyze controlled digital circuits with different Boolean function.                           |
| 4. | Evaluate combinational/sequential circuits and memories.                                       |
| 5. | Translate real-world problems into digital logic formulations using VHDL.                      |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Describe the knowledge of basic logic gates and their design using universal gates.                                       |
| CO2 | Demonstrate the working of combinational and sequential circuits.   |
| CO3 | Integrate and experiment with controlled digital circuits.  |
| CO4 | Appraise combinational/sequential circuits and memories.  |
| CO5 | Schematize, simulate and implement combinational and sequential circuits to solve real-world problems using VHDL systems. |

## SYLLABUS

### List of experiments:

1. **Name of the Experiment: CMOS INVERTER**  
AIM1: Design and implement AND OR and NOT gate using CMOS Inverter.
2. **Name of the Experiment: EX-OR GATE**  
AIM1: To study and verify the truth table of NAND and EX-OR gate using IC 7400.
3. **Name of the Experiment: SEVEN SEGMENT DISPLAY** AIM1: Design and implement SEVEN segment display unit.
4. **Name of the Experiment: ADDER CIRCUITS**  
AIM1: Design and verify half adder and full Adder circuits using gates and IC 7483.
5. **Name of the Experiment: DECODER CIRCUITS** AIM1: Design and implement a 3:8 Decoder.
6. **Name of the Experiment: ENCODER CIRCUITS**  
AIM1: Design and implement 8:3 priority encoder.
7. **Name of the Experiment: MAGNITUDE COMPARATOR**  
AIM1: Design a 4 bit magnitude comparator using combinational circuits.
8. **Name of the Experiment: MUX & DEMUX**  
AIM1: Design and implement 8:1 multiplexer and 1:4 demultiplexer.
9. **Name of the Experiment: ARITHMETIC AND LOGICAL UNIT**  
AIM1: Design ALU with functions of ADD, SUB, INVERT, OR, AND, XOR, INC, DEC, and CMP.
10. **Name of the Experiment: DECADE COUNTER** AIM1: Design and verify the Decade Counter.
11. **Name of the Experiment: DIODE ROM**  
AIM1: Design a ROM (8X4) using a decoder, gates, and diodes.
12. **Name of the Experiment: UP/DOWN COUNTER**  
AIM1: Design of pre settable up/down counter.

**## Implement all the above experiments using VHDL platform and verify.**

### Books recommended:

#### Textbooks:

1. "Digital Design", Morris Mano and Michael D. Ciletti ,5<sup>th</sup> edition PHI
2. "Digital System Design using VHDL", Charles H Roth, Thomson Learning

**Reference books:**

2. Digital computer Electronics AP Malvino, 3rd Edition Mc Graw Hill

**Gaps in the syllabus (to meet Industry/Profession requirements): N/A****POs met through Gaps in the Syllabus: N/A****Topics beyond syllabus/Advanced topics/Design: N/A****POs met through Topics beyond syllabus/Advanced topics/Design: N/A****Course Outcome (CO) Attainment Assessment tools & Evaluation procedure****Direct Assessment**

| Assessment Tool               | % Contribution during CO Assessment |
|-------------------------------|-------------------------------------|
| <b>Progressive Evaluation</b> | <b>(60)</b>                         |
| Attendance Marks              | <b>12</b>                           |
| Day-to-day performance Marks  | <b>06</b>                           |
| Lab Viva marks                | <b>20</b>                           |
| Lab file Marks                | <b>12</b>                           |
| Lab Quiz-I Marks              | <b>10</b>                           |
| <b>End SEM Evaluation</b>     | <b>(40)</b>                         |
| Lab Quiz-II Marks             | <b>10</b>                           |
| Lab performance Marks         | <b>30</b>                           |

**Indirect Assessment –**

1. Student Feedback on Course Outcome

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |   |   |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|---|---|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1                                | 2 | 3 |
| <b>CO1</b>     | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 2                                | 2 | 1 |
| <b>CO2</b>     | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 2                                | 2 | 1 |
| <b>CO3</b>     | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 2                                | 2 | 1 |

|            |   |   |   |   |   |   |   |   |  |   |  |   |   |   |   |
|------------|---|---|---|---|---|---|---|---|--|---|--|---|---|---|---|
| <b>CO4</b> | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |  | 3 |  | 3 | 2 | 2 | 1 |
| <b>CO5</b> | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |  | 3 |  | 3 | 2 | 2 | 1 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods:**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD5, CD9                      |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1, CD5, CD9                      |
| CD3            | Seminars/ Quiz (s)  | CO3                   | CD1, CD5, CD9                      |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1, CD5, CD9                      |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1, CD5, CD9                      |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |



## COURSE INFORMATION SHEET

**Course code:** EC205

**Course title:** Signals and Systems

**Pre-requisite(s):** EC101 Basics of Electronics & Communication Engineering **Co-requisite(s):**

**Credits:** L: 3 T: 0 P: 0 C: 3

**Class schedule per week:** 03 **Class:** B.

Tech.

**Semester / Level:** III/02

**Branch:** ECE

**Name of Teacher:**

### Course Objectives:

This course enables the students:

|    |  |
|----|--|
| 1. | To understand the fundamental characteristics of signals and systems.  |
| 2. | To understand the concepts of different transforms for signal and system.  |
| 3. | To understand signals and systems in terms of both the time and transform domains.                               |
| 4. | To develop the mathematical skills to solve problems involving convolution, filtering, modulation, and sampling. |
| 5. | To understand the response of LTI systems using Transform theory.  |

### Course Outcomes:

After the completion of this course, a student will be able to

|     |   |
|-----|---|
| CO1 | define signal, systems and its importance in life.  |
| CO2 | represent the signal in the time domain as well as in Frequency domain and find the response of the system. |
| CO3 | explain the transform theory and its importance to analyze signal and system.                               |
| CO4 | identify system properties based on impulse response and Fourier analysis.                                  |
| CO5 | explain Sampling theorem and its importance in discrete time systems representation.                        |

## SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <p><b>Module – I</b></p> <p><b>INTRODUCTION TO SIGNALS AND SYSTEMS:</b><br/>Signals and systems as seen in everyday life and in various branches of engineering and science, Signal properties: periodicity, absolute integrability, determinism, and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability.</p>         | 9                      |
| <p><b>Module – II</b></p> <p><b>BEHAVIOR OF CONTINUOUS AND DISCRETE-TIME LTI SYSTEMS:</b><br/>Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-space Representation of systems. StateSpace Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of frequency response and its relation to the impulse response.</p> | 9                      |
| <p><b>Module – III</b></p> <p><b>FOURIER AND LAPLACE TRANSFORMS:</b><br/>Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality, Laplace Transform for continuous-time signals and systems, Transfer/system functions, poles and zeros of system functions and signals, Laplace domain analysis, the solution to differential equations and system behavior.</p>  | 8                      |

|   |   |
|---|---|
| <p><b>Module – IV</b></p> <p><b>Z-TRANSFORM, DTFT, AND DFT:</b><br/> Z-transform, Region of convergence and its properties, Inverse Z transform, properties of ZT, The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT), Parseval's Theorem., Properties of DTFT and DFT, convolution property, multiplication property, Duality, Systems Characterized by Linear Constant Coefficient Difference Equation, The z-Transform for discrete</p> | 7 |
| <p>time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.</p>   |   |
| <p><b>Module – V</b></p> <p><b>SAMPLING AND RECONSTRUCTION:</b><br/> The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. The relation between continuous and discrete time systems. Applications of signal and system theory: modulation for communication, filtering, feedback control systems.</p>  | 7 |

**Books recommended:**

**Textbooks:**

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, “Signals and systems”, Prentice Hall India, 1997.
2. S. Haykin and B. V. Veen, “Signals and Systems”, John Wiley and Sons, 2007.

**Reference books:**

1. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing, Principles, Algorithms, and Applications.
2. Robert A. Gable, Richard A. Roberts, Signals & Linear Systems
3. R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete", 4th edition, Prentice Hall, 1998.
4. Papoulis, "Circuits and Systems: A Modern Approach", HRW, 1980.
5. Douglas K. Lindner, "Introduction to Signals and Systems", McGraw Hill International Edition: c1999.
6. B.P. Lathi, "Signal Processing and Linear Systems", Oxford University Press, c1998.

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

**Signals and Systems** is an advance course; hence it only lays down the foundation of pattern recognition and classification problem.

**POs met through Gaps in the Syllabus**

May be met through laboratory simulations, experiments, and design problems.

### Topics beyond syllabus/Advanced topics/Design

1. Application of **Signals and Systems** in the analysis of time varying signal.
2. Extraction of Pattern vector from time varying signal for the development of decision support system for various applications.

### POs met through Topics beyond syllabus/Advanced topics/Design

Assignments & Seminars

### Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

#### Direct Assessment

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

#### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  | 3                                | 3  | 2  |

|            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <b>CO2</b> | 2 | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| <b>CO3</b> | 2 | 2 | 3 | 3 | 2 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| <b>CO4</b> | 2 | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| <b>CO5</b> | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |   | 1 | 3 | 3 | 2 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Mapping between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD2, CD5, CD8                 |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1, CD2, CD5, CD8                 |
| CD3            | Seminars  | CO3                   | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD4, CD5, CD7, CD9                 |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

## COURSE INFORMATION SHEET

Course code: **EC208**

Course title: **Electronic Measurement Lab**

Pre-requisite(s): **EC101 Basics of Electronics & Communication Engineering** Co-requisite(s):

Credits:        L:        T: 0    P: 4    C: 2

Class schedule per week: 04 Class: B. Tech.

Semester / Level: III/02 Branch: ECE

Name of Teacher:

### Course Objectives

This course enables the students to:

|    |   |
|----|---|
| 1. | Understand the concepts of calibration and measurement.   |
| 2. | Apply the concepts of AC bridges for the measurements of the different electrical parameters.                     |
| 3. | Explain the basic principles of transducers and their uses for the measurements of different physical parameters. |
| 4. | Demonstrate the signal analysis using digital storage oscilloscope.   |
| 5. | Design the signal conditioners and converters for different applications.   |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | To list the functions of various components of a measurement system.  |
| CO2 | Describe the balancing of different AC bridges and calculate unknown resistance, inductance, quality of a coil, and capacitance at balance condition. |
| CO3 | Calibrate and measure different physical parameters using measurement systems.  |
| CO4 | Find and investigate the errors in measuring a parameter.   |
| CO5 | Schematize electronic measurement systems for the measurement of different physical parameters.   |

## **SYLLABUS**

### **List of experiments:**

#### **1. Name of the Experiment**

##### **AC BRIDGES**

Aim1. Balancing Maxwell's Bridge and measurements of Inductance, DC Resistance, and quality factor of a medium Q coil.

Aim2. Balancing Schering's Bridge and measurements of Capacitance, leakage Resistance, and quality factor of a capacitor.

#### **2. Name of the Experiment**

##### **WIEN'S Bridge Measurements**

Aim1. Balancing Wien's Bridge and measurements of frequency of unknown sinusoidal signal.

Aim2. Balancing Wien's Bridge and measurements of total harmonic distortion of a 1Khz nonsinusoidal signal.

#### **3. Name of the Experiment**

##### **STRAIN GAUGES**

Aim1. Calibration and measurement of pressure (in Kg/cm<sup>2</sup>) using diaphragm and strain gauge.

#### **4. Name of the Experiment**

##### **Temperature Transducers**

Aim1. Calibration and measurement of temperature (in °C) using RTD.

Aim2. Calibration and measurement of temperature (in °C) Thermocouple, and Thermistor.

#### **5. Name of the Experiment**

##### **SPEED MEASUREMENT**

Aim1. Measurement of rotating speed in (RPM) using Photo-reflective and Magnetic pickup sensor.

Name of the Experiment

#### **6. LVDT**

Aim1. Calibration and measurement of displacement (in mm) using LVDT.

#### **7. Name of the Experiment**

##### **LEVEL MEASUREMENT**

Aim1. Calibration and measurement of the level (in cm) using Load Cell

#### **8. Name of the Experiment**

##### **TORQUE MEASUREMENT**

Aim1. Torque Measurement (in kgm) using reaction torque sensor.

#### **9. Name of the Experiment**

##### **DAC**

Aim1. Design of bipolar DAC using the R-2R Ladder network.

## 10. Name of the Experiment

### INSTRUMENTATION AMPLIFIER

Aim1. Design and implementation of an instrumentation amplifier for a variable gain of 50, 100 and 200.

## 11. Name of the Experiment

### ADC

Aim1. Design Analog to Digital convertor using voltage to frequency converter technique.

## 12. Name of the Experiment

### RISE TIME MEASUREMENT

Aim1. Measurement of the rise time of the RC circuit using Digital Storage Oscilloscope.

### Books recommended:

#### Textbooks:

1. "Electrical and Electronic Measurements and Instrumentation" by A. K. Sawhney.
2. "Modern Electronic Instrumentation & Measurement Techniques" by Helfrick & Cooper.

Reference books:

1. "Electronic Instrumentation", by H. S. Kalsi.

**Gaps in the syllabus (to meet Industry/Profession requirements):** Visit CIF lab at BIT Mesra.

**POs met through Gaps in the Syllabus:** N/A.

**Topics beyond syllabus/Advanced topics/Design:** Smart Sensors and Transmitters

**POs met through Topics beyond syllabus/Advanced topics/Design:** N/A

**Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure Direct Assessment**

---

| Assessment Tools               | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | 60                                  |
| Semester End Examination       | 40                                  |

| Continuous Internal Assessment     | % Distribution |
|------------------------------------|----------------|
| Day to day performance & Lab files | 30             |
| Quiz                               | 10             |



|             |           |
|-------------|-----------|
| <b>Viva</b> | <b>20</b> |
|-------------|-----------|

| <b>Semester End Examination</b>           | <b>% Distribution</b> |
|---|-----------------------|
| <b>Examination Experiment Performance</b> | <b>30</b>             |
| <b>Quiz</b>                               | <b>10</b>             |

## **Indirect Assessment**

### **1. Students' Feedback on Course Outcome**

#### **Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |   |   |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|---|---|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1                                | 2 | 3 |
| CO1            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 2                                | 2 | 1 |
| CO2            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 2                                | 2 | 1 |
| CO3            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 2                                | 2 | 1 |
| CO4            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 2                                | 2 | 1 |
| CO5            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 2                                | 2 | 1 |

**Correlation Levels 1, 2 or 3 as defined below:**

**1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)**

#### **Mapping Between COs and Course Delivery (CD) methods**

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD5, CD8, CD9          |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1, CD5, CD8, CD9          |
| CD3     | Seminars  | CO3            | CD1, CD5, CD8, CD9          |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1, CD5, CD8, CD9          |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD1, CD5, CD8, CD9          |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9     | Simulation  |                |                             |

## COURSE INFORMATION SHEET

Course code: EC251

Course title: **Probability and Random Processes**

Pre-requisite(s): EC205 Signals and Systems

Co- requisite(s):NA

Credits: L: 3 T: 0 P: 0 C: 3

Class schedule per week: 03 Class: B.

Tech.

Semester / Level: IV/02

Branch: ECE

Name of Teacher:

Course Objectives:

This course enables the students:

|    |   |
|----|---|
| 1. | To explain the random phenomena and impart knowledge on the mathematical modelling of the random experiment.                        |
| 2. | To develop an ability to describe random vectors and their characterization.  |
| 3. | To develop an ability to understand the concept of random processes or stochastic processes.  |
| 4. | To develop an ability to analyze the stochastic processes with the help of probability models and its characterization              |
| 5. | To develop an ability to evaluate different emerging techniques to improve real-time estimation and detection of random parameters. |

Course Outcomes:

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Demonstrate an understanding of the mathematical modelling of the random experiment or random phenomena.       |
| CO2 | Describe random vectors and their characterization.  |
| CO3 | Demonstrate an understanding of the concept of random processes or stochastic processes.                       |
| CO4 | Analyze the stochastic processes with the help of probability models and their characterization.               |
| CO5 | Evaluate the different emerging techniques to improve real-time estimation and detection of random parameters. |

## SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <b>Module – I</b><br><b>Randomness, Uncertainty and its Description</b><br>Random experiments/phenomenon, outcomes of the random experiment, Sample Space, Events, Probability of an event, Concepts of sets and probability theory to explain Random experiments, Probability space; Conditional probability, Independence and Bayes theorem; Combinatorial probability and sampling models.  | 8                      |
| <b>Module – II</b><br><b>Random Variable and its characterization:</b><br>Continuous random variables: distribution function, probability density function, Conditional Densities and Distributions, an example of distributions, Gaussian, Rayleigh, and Rician; exponential, chi-squared; gamma. Discrete random variables: distribution function, probability mass function, Example of random variables and distributions (Bernoulli, binomial, Poisson, geometric, negative binomial, etc.), Expectations, Variance, MGF and Characteristics Function of Random Variable, moments of Random Variable. | 9                      |
| <b>Module – III</b><br><b>Random vector and its characterization:</b><br>Joint Events, Joint CDF and PDF, Properties of Joint CDF and PDF, Bivariate Gaussian Distributions, Joint Moments, Random Vectors, Vector Gaussian Random Variables, Moments of Random Vectors, Independence of two random vectors,   | 9                      |
| <b>Module – IV</b><br><b>Inequalities, Convergences, and Limit Theorems:</b><br>Random sequences Markov, Chebyshev and Chernoff bounds; modes of convergence (everywhere, almost everywhere, probability, distribution and mean square); Stochastic convergence, the law of large numbers, central limit theorem, Limit theorems; Strong and weak laws of large numbers.   | 8                      |

|  |          |
|--|----------|
| <b>Module – V</b><br><b>Random Processes and Linear Systems:</b><br>Random Data/Signals, stationarity; mean, correlation, and covariance functions, WSS random process; autocorrelation and cross-correlation functions; transmission of a random process through a linear System; power spectral density; white random process; Gaussian process; Poisson process, Application of | <b>6</b> |
| Probability and Random Processes to understand important domain like digital communication, estimation and information theory.   |          |

**Text Books:**

1. Papoulis. A.,” Probability, Random variables, and Stochastic Processes”, McGraw Hill, 2002.
2. H.Stark & J.W.Woods, “Probability, Random Processes and Estimations Theory for Engineers”, (2/e), Prentice Hall, 1994

**Reference Book:**

1. E.Wong, “Introduction to Random Processes”, Springer Verlag, 1983.
2. W.A.Gardner, “Introduction to Random Processes”, (2/e), McGraw Hill, 1990.
3. Davenport,” Probability and Random Processes for Scientist and Engineers”, McGraw-Hill, 1970.

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

**Probability and Random Processes** is an advance course; hence it only lays down the foundation of pattern recognition and classification problem.

**POs met through Gaps in the Syllabus**

May be met through laboratory simulations, experiments, and design problems.

**Topics beyond syllabus/Advanced topics/Design**

1. Application of **Probability and Random Processes** in the analysis of time varying signal.
2. Extraction of Pattern vector from time varying signal for the development of decision support system for various applications.

**POs met through Topics beyond syllabus/Advanced topics/Design**

Assignments & Seminars

## Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

### Direct Assessment

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  | 3                                | 3  | 1  |
| CO2            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  | 3                                | 3  | 1  |
| CO3            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 3 | 3 | 3  | 3  | 3  | 3                                | 3  | 1  |
| CO4            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  | 3                                | 3  | 1  |

|            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <b>CO5</b> | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 1 |
|------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Mapping between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD2, CD5, CD8                 |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1, CD2, CD5, CD8                 |
| CD3            | Seminars  | CO3                   | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD4, CD5, CD7, CD9                 |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

## COURSE INFORMATION SHEET

Course code: **EC253**

Course title: **Analog Circuits**

Pre-requisite(s): **EC101 Basics of Electronics & Communication Engineering**

Co-requisite(s): **None**

**Credits: L: 3 T: 0 P: 0 C: 3.0**

**Class schedule per week: 03**

**Class: B. Tech**

**Semester / Level: 04**

**Branch: ECE**

**Name of Teacher:**

### Course Objectives

This course enables the students:

|    |   |
|----|---|
| 1. | To help them understand the operation of Transistors for low frequency applications and power amplifiers            |
| 2. | To know the operation of multistage amplifiers and transistors for high frequency applications and tuned amplifiers |
| 3. | To help them understand the operation of feedback amplifiers and oscillators  |
| 4. | To help them realize the non-linear applications of op-amp and filters  |
| 5. | To help them design the analog-to-digital and digital-to-analog converters  |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Understand the concept of amplifiers, oscillators and active filter circuits. |
|-----|---|



|     |  |
|-----|--|
| CO2 | Demonstrate the working of amplifiers, oscillators and active filter circuits.     |
| CO3 | Analyze amplifiers, filters at low and high frequency.                             |
| CO4 | Evaluate amplifiers, filters and converter circuits.                               |
| CO5 | Schematize amplifiers, oscillators and filter circuits for practical applications. |

## SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <b>Module – I</b><br>Review of hybrid models of BJT, simplified hybrid models of CE, CB, CC configurations, CE amplifier with emitter resistance, Emitter follower, Highinput-resistance transistor circuits: Darlington Circuit, Cascode Amplifier. <b>Transistor Power Amplifiers:</b> Circuits and Operations of Class A, Class B, Class C and Push-Pull Configurations.   | <b>10</b>              |
| <b>Module – II</b><br>Multistage amplifiers: Frequency response of an amplifier, Bandpass of cascaded stages, Low frequency response of RC coupled amplifier. Transistors at High Frequencies: Hybrid $\pi$ model and parameters; high frequency response of CE transistor amplifier, Gain-Bandwidth product, Emitter follower at high frequencies, FET (CS & CD) at high frequencies. Tuned amplifiers: single-tuned amplifier, synchronously tuned amplifier, Gain-Bandwidth product. | <b>10</b>              |

|   |                 |
|---|-----------------|
| <p><b>Module – III</b><br/> <b>Feedback Amplifiers:</b> Classification of amplifiers, feedback concept, transfer gain with feedback, characteristics of negative-feedback amplifier, method of analysis of feedback amplifiers, voltage-series feedback, current-series feedback, current-shunt feedback, voltage-shunt feedback. Concept of stability, gain margin and phase margin. <b>Oscillators:</b> RC phase shift oscillator, Wien bridge oscillator, crystal oscillator. Current mirror circuits.</p> | <p><b>7</b></p> |
| <p><b>Module – IV</b><br/> Emitter-coupled differential amplifier, transfer characteristics of differential amplifier, IC of operational amplifier: gain stages and output stages, Electronic analog computation using op-amp, Non-linear applications of OP-AMP: zerocrossing detector, precision rectifier, peak detector, logarithmic amplifier, Schmitt trigger. <b>Active filters:</b> Low pass, high pass, band pass and band stop, design guidelines.</p>  | <p><b>8</b></p> |
| <p><b>Module – V</b><br/> Sample-and-hold circuit, <b>D/A converters:</b> Weighted-resistor D/A Converter, R2R Ladder type D/A converter, Specifications for D/A Converters. <b>A/D Converters:</b> Parallel-comparator type A/D converter, Successive approximation type A/D converter, Counter type A/D converter, Dual slope converter, Comparison of converter types.</p>   | <p><b>5</b></p> |

**Text books:**

1. “Integrated Electronics”, Millman & Halkias, TMH
2. “Electronics Circuits: Discrete and Integrated”, D. Schilling and C. Belove, McGraw-Hill
3. “Operational Amplifiers and Linear Integrated Circuits” by R. A. Gayakwad, PHI
4. “Digital Integrated Electronics”. Taub & Schilling, TMH.

**Reference books:**

1. “Electronic Devices and Circuit”, Millman , Halkias, S Jit, TMH
2. “Micro Electronic Circuits”, A. S. Sedra and K. C. Smith, Oxford press

**Gaps in the syllabus (to meet Industry/Profession requirements):**

**POs met through Gaps in the Syllabus:**

**Topics beyond syllabus/Advanced topics/Design:**

**POs met through Topics beyond syllabus/Advanced topics/Design:**

**Course Delivery Methods**

|     |   |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors      |
| CD2 | Assignments   |
| CD3 | Laboratory experiments/teaching aids/Seminars               |
| CD4 | Industrial/guest lectures                                   |
| CD5 | Industrial visits/in-plant training                         |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation  |

### **Course Outcome (CO) Attainment Assessment tools & Evaluation procedure**

#### **Direct Assessment**

| <b>Assessment Tools</b>        | <b>% Contribution during CO Assessment</b> |
|--------------------------------|--|
| Continuous Internal Assessment | 50   |
| Semester End Examination       | 50   |

| <b>Continuous Internal Assessment</b> | <b>% Distribution</b> |
|---------------------------------------|-----------------------|
| Mid semester examination              | 25                    |
| Two quizzes                           | 20 (2×10)             |
| Teacher's Assessment                  | 5                     |

#### **Indirect Assessment**

1. Student Feedback on Faculty
2. Student Feedback on Course

#### **Course Delivery Methods**

|     |  |
|-----|--|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
|-----|--|

|     |   |
|-----|---|
| CD2 | Assignments   |
| CD3 | Laboratory experiments/Teaching aids/Seminars               |
| CD4 | Mini Projects   |
| CD5 | Industrial visits/in-plant training                         |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation  |

### Mapping between Course Outcomes and Program Outcomes and Program Specific Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |
| CO2            | 3                      | 3 | 2 | 3 | 3 | 2 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |
| CO3            | 3                      | 3 | 2 | 3 | 3 | 2 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |
| CO4            | 3                      | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |
| CO5            | 3                      | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

### Mapping between Course Outcomes and Course Delivery Method

| Course Outcomes | Course Delivery Method  |
|-----------------|-------------------------|
| CO1             | CD1, CD2, CD3, CD6, CD7 |
| CO2             | CD1, CD2, CD3, CD6, CD7 |
| CO3             | CD1, CD2, CD3, CD6, CD7 |
| CO4             | CD1, CD2, CD3, CD6, CD7 |

|     |                         |
|-----|-------------------------|
| CO5 | CD1, CD2, CD3, CD6, CD7 |
|-----|-------------------------|

## **COURSE INFORMATION SHEET**

Course code: **EC254**

Course title: **Analog Circuits Lab.**

Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering

Co- requisite(s): Analog Circuits

Credits: L: 0 T: 0 P: 3 C: 1.5 Class

periods per week: 03 Class: B. Tech.

Semester / Level: IV

Branch: ECE

Name of Teacher:

## Course Objectives

This course enables the students to:

|    |   |
|----|---|
| 1. | Realize the two-stage amplifier and simple tuned amplifier circuits.              |
| 2. | Implement the Feedback amplifier circuits.  |
| 3. | Realize the differential amplifier and oscillator.                                |
| 4. | Realize the active band pass, band stop filter circuits.                          |
| 5. | Know the operation of analog-to-digital and digital-to-analog converter circuits. |

## Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Design two-stage amplifier and simple tuned amplifier circuits.          |
| CO2 | Analyze and analyze the feedback amplifier circuits.                     |
| CO3 | Characterize and Characterize the differential amplifier and oscillator. |
| CO4 | Characterize the active band pass, band stop filter circuits.            |
| CO5 | Design the analog-to-digital and digital-to-analog converter circuits.   |

## SYLLABUS

### List of Compulsory experiments:

| Experiment No. | Name of the Experiments  |
|----------------|--|
| 1.             | Determine the h-parameters: $h_{ie}$ and $h_{fe}$ of a transistor.<br>AIM1: Design a CE transistor circuit to evaluate the $h_{ie}$ .<br>AIM2: Design a CE transistor circuit to evaluate the $h_{fe}$ .   |
| 2.             | Design and obtain the frequency response characteristics of Darlington pair amplifier.<br>AIM1: Design the circuit of a Darlington pair amplifier in emitter follower configuration and find the current gain of Darlington pair.<br>AIM2: Find the frequency response of the Darlington pair amplifier. |

|     |  |
|-----|--|
| 3.  | <p>Determine the frequency response of Cascode Amplifier and find the input resistance and output resistance of the amplifier.</p> <p>AIM1: Design the BJT based cascode amplifier and find the frequency response.<br/>AIM2: Find the input and output resistance of the amplifier.</p>   |
| 4.  | <p>Find the frequency response of (a) single stage and (b) multistage amplifiers. Determine the mid-band gain and bandwidth of the amplifiers.</p> <p>AIM1: Find the frequency response of single stage CE amplifier and determine the mid-band gain and bandwidth.<br/>AIM2: Find the frequency response of multistage CE amplifiers and determine the mid-band gain and bandwidth.</p> |
| 5.  | <p>Design a BJT based tuned amplifier. Find its frequency response.</p> <p>AIM1: Design a BJT based tuned amplifier and Find its frequency response.<br/>AIM2: Compare the theoretical resonant frequency with the experimental result.</p>  |
| 6.  | <p>Design (a) current-series, and (b) voltage-shunt feedback amplifier. Find the frequency response of both amplifiers with and without feedback.</p> <p>AIM1: Design current-series feedback amplifier and Find the frequency response.<br/>AIM2: Design voltage-shunt feedback amplifier and Find the frequency response.</p>  |
| 7.  | <p>Design a Wein bridge oscillator.</p> <p>AIM1: Design the Wein bridge oscillator using BJT / op-amp and calculate the theoretical gain of the main amplifier.<br/>AIM2: Observe and plot the output waveform.</p>  |
| 8.  | <p>Design a differential amplifier using BJT and determine the CMRR.</p> <p>AIM1: Design a differential amplifier using BJT and determine the differential mode gain at different frequencies.<br/>AIM2: Design a differential amplifier using BJT and determine the common mode gain at different frequencies. Find the CMRR at those frequencies.</p>                                  |
| 9.  | <p>Design and determine the characteristics of logarithmic and antilogarithmic amplifiers using op-amp.</p> <p>AIM1: Design a logarithmic amplifiers using op-amp and plot the output.<br/>AIM2: Design an antilogarithmic amplifiers using op-amp and plot the output.</p>  |
| 10. | <p>Design and determine the characteristics of Active filters: band pass, band stop.</p> <p>AIM1: Design a band pass filter and find frequency response. AIM2: Design a band stop filter and find frequency response.</p>  |
| 11. | <p>Construction of R-2R Ladder type 4-bit D/A converter.</p> <p>AIM1: Design an R-2R Ladder type 4-bit D/A converter using op-amp and find the analog output voltage for all the digital inputs.<br/>AIM2: Find the resolution of the converter.</p>   |
| 12. | <p>Construction of counter type A/D Converter.</p> <p>AIM1: Design a counter type A/D converter and find the digital output bits for different analog inputs.<br/>AIM2: Find the resolution of the converter.</p>  |

**Text books:**

1. “Integrated Electronics”, Millman & Halkias, McGraw Hill.

**Reference books:**

1. “Electronic Devices and Circuit Theory”, Nashelesky & Boylestead, PHI/Low price edition.

**Gaps in the syllabus (to meet Industry/Profession requirements):****POs met through Gaps in the Syllabus:**

**Topics beyond syllabus/Advanced topics/Design:** through experiments involving design/modelling of device/circuits on advanced topics

**POs met through Topics beyond syllabus/Advanced topics/Design:** through experiments involving design/modelling of device/circuits on advanced topics

**Course Delivery Methods**

|     |   |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors      |
| CD2 | Assignments   |
| CD3 | Laboratory experiments/teaching aids/Seminars               |
| CD4 | Industrial/guest lectures                                   |
| CD5 | Industrial visits/in-plant training                         |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation  |

**Course Outcome (CO) Attainment Assessment tools & Evaluation procedure****Course Delivery Methods**

|     |  |
|-----|--|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments  |
| CD3 | Laboratory experiments/teaching aids/Seminars          |



|     |   |
|-----|---|
| CD4 | Industrial/guest lectures                                   |
| CD5 | Industrial visits/in-plant training                         |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation  |

### Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

#### Direct Assessment

| Assessment Tools               | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | 60                                  |
| Semester End Examination       | 40                                  |

| Continuous Internal Assessment     | % Distribution |
|------------------------------------|----------------|
| Day to day performance & Lab files | 30             |
| Quiz(zes)                          | 10             |
| Viva                               | 20             |

| Semester End Examination   | % Distribution |
|----------------------------|----------------|
| Examination<br>Performance | 30             |
| Quiz                       | 10             |

#### Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

#### Course Delivery Methods

|     |   |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors      |
| CD2 | Assignments   |
| CD3 | Laboratory experiments/Teaching aids/Seminars               |
| CD4 | Mini Projects   |
| CD5 | Industrial visits/in-plant training                         |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation  |

#### Mapping between Course Outcomes and Program Outcomes and Program Specific Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |
| CO2            | 3                      | 3 | 2 | 3 | 3 | 2 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |
| CO3            | 3                      | 3 | 2 | 3 | 3 | 2 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |
| CO4            | 3                      | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |
| CO5            | 3                      | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Mapping between Course Outcomes and Course Delivery Method**

| Course Outcomes | Course Delivery Method |
|-----------------|------------------------|
| CO1             | CD3, CD7               |
| CO2             | CD3, CD7               |
| CO3             | CD3, CD7               |
| CO4             | CD3, CD7               |
| CO5             | CD3, CD7               |

## COURSE INFORMATION SHEET

**Course Code: EC255**

**Course Title: Analog Communication**

**Pre-requisite(s):** Good understanding of mathematical tools like integration, differentiation etc.

**Co- requisite(s):**

**Credits:** L: 3 T: 0 P: 0 C:3

**Class schedule per week: 03**

**Class: B. Tech.**

**Semester / Level: Fourth/Second**

**Branch: Electronics & Communication Engineering**

**Name of Teacher:**

### **Course Objectives**

This course envisions to impart to students to:

|    |   |
|----|---|
| 1. | Explain analog communication system and representation of signals.  |
| 2. | Explain different methods of amplitude modulation and demodulation schemes, their design, operation and applications. |
| 3. | Explain different methods of angle modulation and demodulation schemes, their design, operation and applications.     |
| 4. | Explain different methods of pulse modulation, their design, operation and applications.                              |
| 5. | Evaluate the performance of analog communication system in the presence of noise.                                     |

### **Course Outcomes**

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Demonstrate an understanding on analog communication system and representation of signals.  |
| CO2 | Demonstrate an understanding on different methods of amplitude modulation and demodulation schemes, their design, operation and applications. |
| CO3 | Demonstrate an understanding on different methods of angle modulation and demodulation schemes, their design, operation and applications.     |
| CO4 | Demonstrate an understanding on different methods of pulse modulation, their design, operation and applications.                              |

## SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b><br/> <b>Signal analysis</b><br/>           Time domain and frequency domain representation of a signal, fourier series, complex fourier spectrum (discrete spectrum or line spectrum), fourier transform, properties of fourier transform, energy and power spectral density spectrum, distortion less transmission, causality and physical realizability, pre-envelope and canonical representation of band pass signals.</p>   | 10                     |
| <p><b>Module – II</b><br/> <b>Amplitude modulation- demodulation communication systems</b><br/>           Amplitude modulation, square law modulator, switching modulator, square law demodulator, envelope detector, double side band suppressed carrier modulation, balanced and ring modulators, single side band modulation, frequency discrimination and phase discrimination modulators, coherent detection of SSB, frequency division multiplexing and time division multiplexing, super heterodyne AM receiver and its characteristics.</p> | 7                      |
| <p><b>Module – III</b><br/> <b>Angle modulation - demodulation communication systems</b><br/>           Basics of frequency and phase modulation, single tone frequency modulation, NBFM, WBFM, Transmission bandwidth of FM wave, indirect and direct methods of FM generation, frequency discriminator, phase locked loop demodulator, super heterodyne FM receiver.</p>  | 7                      |
| <p><b>Module – IV</b><br/> <b>Pulse modulation demodulation communication systems</b><br/>           Sampling process, pulse amplitude modulation, pulse duration modulation, pulse position modulation.</p>  | 10                     |

|  |                 |
|--|-----------------|
| <p><b>Module – V</b><br/> <b>Noise in communication systems</b><br/> Noise, shot noise, thermal noise, white noise, noise equivalent bandwidth, signal to noise ratio for coherent detection of DSBSC, SNR for coherent reception with SSB modulation, SNR for AM receiver using envelope detection, Noise in FM reception, FM Threshold effect, pre emphasis and de-emphasis.</p> | <p><b>6</b></p> |
|--|-----------------|

**Text Books:**

1. Simon Haykin, “Communication Systems”, Wiley Eastern Limited, New Delhi, 2016, 4/e.
2. B. P. Lathi and Zhi Ding, “Modern Digital and Analog Communication Systems”, Oxford University Press, 2011, 4/e, (Indian Edition)

**Reference Books:**

1. John G. Proakis and Masoud Salehi, “Fundamentals of Communication Systems” Pearson Education, Inc., New Delhi, 2013.
2. Bruce Carlson and Paul B. Crilly, “Communication Systems: An Introduction to signals and Noise in Electrical Communication”, Tata McGraw Hills Education Pvt. Ltd., New Delhi, 2011, 5/e.

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

**POs met through Gaps in the Syllabus:**

**Topics beyond syllabus/Advanced topics/Design:**

**POs met through Topics beyond syllabus/Advanced topics/Design:**

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:PO2**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher’s Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students’ Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 2 | 2 | 1 | - | - | - | - | - | -  | -  | 2  | 3                                | 2  | 1  |
| CO2            | 3                      | 3 | 3 | 3 | 2 | - | - | - | - | -  | -  | 1  | 3                                | 2  | 2  |
| CO3            | 3                      | 3 | 3 | 3 | 2 | - | - | - | - | -  | -  | 1  | 3                                | 2  | 1  |
| CO4            | 3                      | 3 | 3 | 3 | 2 | - | - | - | - | -  | -  | 1  | 3                                | 2  | 3  |
| CO5            | 3                      | 3 | 3 | 3 | 3 | - | - | - | - | -  | -  | 1  | 3                                | 2  | 2  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High) **Mapping**

### Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD8                    |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1 ,CD8                    |
| CD3     | Seminars  | CO3            | CD1, CD8                    |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1, CD8                    |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD1,CD8                     |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9     | Simulation  |                |                             |

## COURSE INFORMATION SHEET

**Course Code: EC 257**

**Course Title: Electromagnetic Field and**

**Waves Pre-requisite(s): Engineering**

**Mathematics Co- requisite(s):**

**Credits: L: 3 T: 0 P: 3**

**Class schedule per week: 03**

**Class: B. Tech.**

**Semester / Level: Four**

**Branch: Electronics and Communication Engineering**

**Name of Teacher:**

### **Course Objectives**

This course envisions to impart to students to:

|    |  |
|----|--|
| 1. | To apply the basic skills of mathematics, physics and science to understand, design and develop various engineering problems involving electromagnetic fields. |
| 2. | To lay the foundations of electromagnetic engineering and its applications in modern communications involving both wireless and guided wave medium.            |
| 3. | To analyse the electromagnetic wave propagation in guided and unguided medium having different medium properties and different boundary conditions.            |
| 4. | To develop an ability to identify, formulate, and solve electromagnetic engineering problems.  |
| 5. | To review and present the literature ethically and also develop the skill to work individually or in a team.   |

### **Course Outcomes**

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Explain the basic concepts of time varying electric and magnetic fields in different electromagnetic media.   |
| CO2 | Analyze Maxwell's equation in differential and integral forms and apply them to diverse engineering problems.   |
| CO3 | Examine and understand the phenomena of wave propagation in different media and its interfaces as well as in guided medium and its applications in microwave engineering. |
| CO4 | Identify, formulate and solve electromagnetic engineering problems.   |
| CO5 | Work in a small team and communicate electromagnetic concepts both orally and in writing following ethical rules.   |

## SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <b>Module – I</b><br><b>Introduction to Maxwell's Equations:</b> Faraday's Law, Transformer & Motional EMF, Displacement Current, Maxwell's Equations (Generalized form).<br><b>Boundary Conditions and Wave Equation:</b> Electromagnetic Boundary Conditions<br><b>Time varying Potentials &amp; Fields:</b> Time varying Potentials, Time harmonic fields, Time harmonics Maxwell's Equations.                            | <b>8</b>               |
| <b>Module – II</b><br><b>EM Wave propagation:</b> Wave Equation & Plane Waves in unbounded homogeneous, plane waves in free space and lossy media, Skin depth, Poynting vector and Power considerations, Polarization of Electromagnetic waves, Reflection of a plane wave at Normal incidence and Oblique incidence. Parallel & Perpendicular Polarization at perfect conducting & dielectric boundaries, Brewster's Angle. | <b>9</b>               |



|  |          |
|--|----------|
| <b>Module – III</b><br><b>Transmission lines:</b> Transmission line parameters & Equations, Input Impedance, SWR and Power , The Smith Chart, Quarter Wave Transformer Matching, Single Stub Tuner(Matching), Slotted line (Impedance Measurement, Transients on transmission lines, Microstrip Transmission lines, strip lines, Slot lines and Co-planar lines. | <b>9</b> |
| <b>Module – IV</b><br><b>Waveguides:</b> Transverse Electric and Transverse Magnetic wave propagation in Rectangular Waveguide, Rectangular Cavity Resonator, Circular Cavity Resonator, Quality factor of the rectangular Cavity Resonator.   | <b>8</b> |
| <b>Module – V</b><br><b>Antennas:</b> Radiation from the Hertz dipole, Power radiated by Hertzian dipole, Radiation Parameters of antenna, Monopole and Dipole antenna.  | <b>6</b> |

**Text Books:**

1. Principle of Electromagnetics, Matthew N.O. *Sadiku* & S.V. Kulkarni, Oxford University Press, Sixth Edition.

**Reference Books:**

1. Electromagnetics field Theory and Transmission Line G.S.N Raju, Pearson Education
2. Electromagnetic Waves and Radiating Systems, 2/e, E. C. Jordan and K. G. Balmain, PHI.
3. Electromagnetics, David Cheng, Prentice Hall

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

**EM field and Waves** is a basic course, hence it only lays down the foundation of Advanced Courses.

**POs met through Gaps in the Syllabus**

May be met through laboratory simulations, experiments, and design problems.

**Topics beyond syllabus/Advanced topics/Design**

3. Application of EM fields and Waves in the analysis of EM interference
4. Design of Omni directional Antennas for various applications.

**POs met through Topics beyond syllabus/Advanced topics/Design**

Assignments & Seminars

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 1 | 1 | 1 | 2 |   |   |   | 1 | 1  |    | 2  | 3                                | 1  | 2  |
| CO2            | 2                      | 1 |   | 1 | 2 |   |   |   | 1 | 1  |    | 2  | 2                                | 2  | 2  |
| CO3            | 3                      | 1 |   | 1 | 2 |   |   |   | 1 | 1  |    | 2  | 2                                | 2  | 2  |
| CO4            | 1                      | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1  | 1  | 2  | 3                                | 3  | 3  |
| CO5            | 1                      | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1  |    | 2  | 2                                | 2  | 2  |

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used        |
|---------|---|----------------|------------------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD2, CD5, CD8                 |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1, CD2, CD5, CD8                 |
| CD3     | Seminars  | CO3            | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD4, CD5, CD7, CD9                 |
| CD6     | Industrial/Guest Lectures                                   |                |                                    |
| CD7     | Industrial Visits/In-plant Training                         |                |                                    |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                                    |

|     |            |  |  |
|-----|------------|--|--|
| CD9 | Simulation |  |  |
|-----|------------|--|--|

### **COURSE INFORMATION SHEET**

**Course Code: EC 258**

**Course Title: Electromagnetic Waves Lab.**

**Pre-requisite(s): MATLAB**

**Co- requisite(s):**

**Credits: L: 0 T: 0 P: 3**

**Class schedule per week: 03**

**Class: B. Tech.**

**Semester / Level: Four**

**Branch: Electronics and Communication Engineering**

**Name of Teacher:**

**Course Objectives**

This course envisions to impart to students to:

|    |   |
|----|---|
| 1. | Analyze the Maxwell's equation in explaining the phenomenon of wave propagation.                      |
| 2. | Apply Maxwell's equation in solving the time varying electromagnetic field problems.                  |
| 3. | Apply appropriate boundary conditions to solve the time varying Electromagnetic phenomena.            |
| 4. | Characterize the wave propagation in guided and unguided media under different media characteristics. |
| 5. | Develop an insight to visualize and solve practical electromagnetic engineering problems.             |

### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Formulate the electromagnetic problem and solve them using MATLAB simulation tool.   |
| CO2 | Visualize the wave propagation in different media and its implication on transmission, reflection and propagation phenomena. |
| CO3 | Visualize the concept of wave propagation in guided media such as transmission lines and waveguides.                         |
| CO4 | Visualize the concept of wave polarization.  |
| CO5 | Visualize and solve practical Electromagnetic engineering problems.  |

### SYLLABUS

#### LIST OF EXPERIMENTS:

1. Using MATLAB, simulate and plot the phenomenon of Skin effect in current carrying conductors as a function of the conductivity of the conductor and the frequency of operation.  
**AIM**  
Study the effect of frequency and conductivity on skin depth.
2. Using MATLAB, simulate and plot the variation of the time varying field as a function of distance. Also plot the waveforms to depict linear, circular and elliptical polarization of the wave.  
**AIM**  
Study the polarization phenomena and understand its significance in communication.

3. A parallel-plate capacitor with plate area  $5 \text{ cm}^2$  and plate separation of  $3 \text{ mm}$  has a voltage  $50 \sin 10^3 t \text{ V}$  applied to its plates. Using MATLAB, Compute the displacement current assuming (i)  $\epsilon = \epsilon_0$  (ii)  $\epsilon = 2\epsilon_0$

**AIM**

Study the effect of dielectric material on displacement current.

4. An electric field in free space is given by  $E = 50 \cos (10^8 t + \beta x) a_y \text{ V/m}$ . Using MATLAB, Compute (i)  $k$ ,  $\lambda$  and  $T$  (ii) the time it takes to travel a distance of  $\lambda/2$ . (iii) Plot the wave at  $t = 0, T/4$ , and  $T/2$ .

**AIM**

Study the characteristics of the EM wave.

5. Using MATLAB Compute the following problems

(a) In free space,  $E = 20 \cos (\omega t - 50 x) a_y \text{ V/m}$ . Compute (i)  $J_d$  (ii)  $H$  (iii)  $\omega$

(b) In a medium characterized by  $\sigma = 0$ ,  $\mu = \mu_0$ ,  $\epsilon = 4\epsilon_0$ , and  $E = 20 \sin (10^8 t - \beta z) a_y \text{ V/m}$

**AIM**

Examine the characteristics of the EM wave in free space and in a specified medium.

6. A plane wave propagating through a medium with  $\epsilon_r = 8$ ,  $\mu_r = 2$  and  $E = 0.5 e^{-z/3} \sin(10^8 t - \beta z) a_x \text{ V/m}$ . Using MATLAB, compute (i)  $\beta$  (ii) the loss tangent (c) Intrinsic impedance (iv) Wave velocity (v)  $H$  field.

**AIM**

Examine the characteristics of the EM wave in the specified dielectric medium.

7. In free space ( $z \leq 0$ ), a plane wave with  $H_i = 10 \cos (10^8 t - \beta z) a_x \text{ mA/m}$  is incident normally on a lossless medium ( $\mu = 8\mu_0$ ,  $\epsilon = 2\epsilon_0$ ) in region  $z \geq 0$ . Using MATLAB, compute and plot the reflected wave  $H_r$ ,  $E_r$  and the transmitted wave  $H_t$  and  $E_t$ .

**AIM**

Study the reflected and transmitted phenomena of Plane wave at normal incidence on a lossless dielectric medium.

8. Given a uniform plane wave in air as  $E_i = 40 \cos(\omega t - \beta z)a_x + 30 \sin(\omega t - \beta z)a_y \text{ V/m}$ . Using MATLAB compute and plot

(i)  $H_i$

(ii) If the wave encounters a perfectly conducting plate normal to the  $z$ -axis at  $z = 0$ , find the reflected wave  $E_r$  and  $H_r$ .

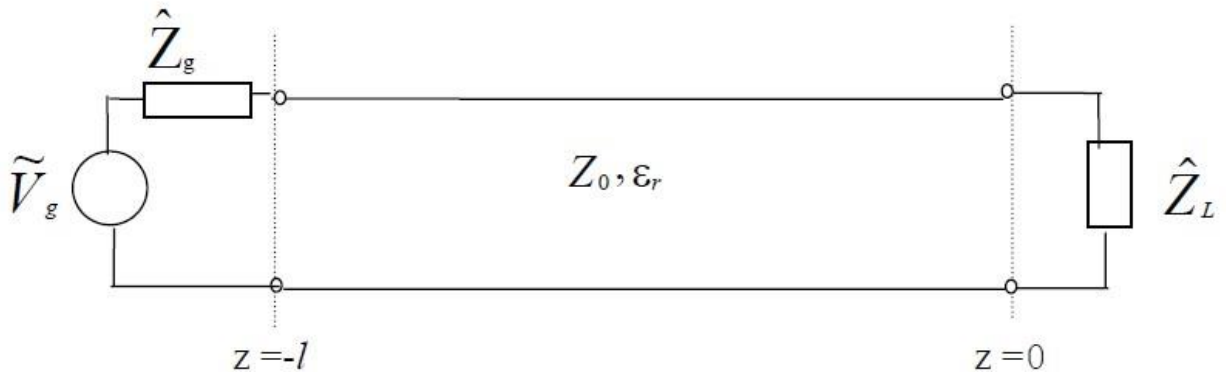
(iii) The total  $E$  and  $H$  fields for  $z \leq 0$ .

(iv) The time-average Poynting vectors for  $z \leq 0$  and  $z \geq 0$ .

**AIM**

Study the phenomenon of plane wave propagation and power calculation.

9.



For the transmission line system shown,

$f = 600 \text{ MHz}$ ,  $Z_g = 50 \Omega$ ,  $Z_0 = 50 \Omega$ ,  $l = 0.75 \lambda_0$ ,  $\epsilon_r = 1.0$ . The values of the load

is given as (i)  $Z_L = 0 \Omega$

(ii)  $Z_L = \text{open}$

(iii)  $Z_L = 100 \Omega$

(iv)  $Z_L = (25 + j 25) \Omega$

(v)  $Z_L = (25 - j 25) \Omega$

Using MATLAB, obtain the following for each of the loads given above.

- The Standing Wave pattern
- Calculate SWR for each load. And plot the normalized SWR pattern.

**AIM**

Study the propagation of EM wave in two wire transmission line and stud the effect of load on propagation characteristics.

10. A right-hand circularly polarized wave at 1.5 GHz is propagating through a material with  $\epsilon_r = 6.2$  and  $\mu_r = 2.0$  and arrives at an interface with air. It is incident at an elevation angle of  $15^\circ$  and an azimuthal angle of  $45^\circ$ . The wave has an amplitude of 12 V/m. The interface lies in the x-y plane. Using MATLAB, Compute

(i) The angle of incidence  $\theta_1$ .

(ii) The critical angle and the Brewster's angles for this configuration for both polarizations.

(iii) The reflection and transmission coefficients for both polarizations.

(iv) The percent reflectance and transmittance for both polarizations. Verify conservation of energy

**AIM**

Study the reflected and transmitted phenomena of Plane wave under oblique incidence condition.

11. Use MATLAB to visualize the first four electromagnetic modes in a rectangular waveguide with  $a/b = 2.25$  and plot the phase constant  $\beta$  of the fundamental mode in from 0.5 GHz up to 3.0 GHz.

**AIM**

Study the propagation of EM wave in rectangular waveguide and study the dispersion characteristics.

12. Write a MATLAB program that determines the first 20 modes supported by an air-filled rectangular waveguide and sorts them to be in ascending order, starting with the fundamental mode. The program should output a formatted table that labels each mode as either  $TE_{mn}$  or  $TM_{mn}$  along with its cutoff frequency. Create five difference tables, one for each of the following five cases: Table 1:  $a = 0.5$  cm and  $b = 1.0$  cm Table 2:  $a = 1.0$  cm and  $b = 1.0$  cm Table 3:  $a = 1.5$  cm and  $b = 1.0$  cm Table 4:  $a = 2.0$  cm and  $b = 1.0$  cm Table 5:  $a = 2.5$  cm and  $b = 1.0$  cm.

**AIM**

Study the propagation of EM wave in rectangular waveguide and study the effect of waveguide dimension on mode characteristics.

**Text books:**

1. Principle of Electromagnetics, Matthew N.O. *Sadiku* & S.V. Kulkarni, Oxford University Press, Sixth Edition.

**Reference books:**

1. Electromagnetics field Theory and Transmission Line G.S.N Raju, Pearson Education
2. Electromagnetic Waves and Radiating Systems, 2/e, E. C. Jordan and K. G. Balmain, PHI.
3. Electromagnetics, David Cheng, Prentice Hall

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

NA

**POs met through Gaps in the Syllabus**

NA

**Topics beyond syllabus/Advanced topics/Design**

Simulations based on advanced topics after completion of compulsory twelve experiments.

**POs met through Topics beyond syllabus/Advanced topics/Design**

Assignments & Seminars

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool              | % Contribution during CO Assessment |
|------------------------------|-------------------------------------|
| Progressive Evaluation       | (60)                                |
| Attendance Marks             | 12                                  |
| Lab file Marks               | 12                                  |
| Viva Marks                   | 24                                  |
| Day-to-day performance Marks | 12                                  |
| End SEM Evaluation           | (40)                                |
| Lab quiz Marks               | 20                                  |
| Lab performance Marks        | 20                                  |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 2  | 1  | 3  | 3                                | 2  | 1  |
| CO2            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 2  | 1  | 3  | 2                                | 2  | 2  |
| CO3            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 2  | 1  | 3  | 2                                | 2  | 2  |
| CO4            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 2  | 1  | 3  | 2                                | 2  | 2  |
| CO5            | 1                      | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1  | 1  | 2  | 2                                | 2  | 2  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD2, CD5, CD8          |



|     |   |     |                                    |
|-----|---|-----|------------------------------------|
| CD2 | Tutorials/Assignments                                       | CO2 | CD1, CD2, CD5, CD8                 |
| CD3 | Seminars  | CO3 | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD4 | Mini Projects/Projects                                      | CO4 | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD5 | Laboratory Experiments/Teaching Aids                        | CO5 | CD4, CD5, CD7, CD9                 |
| CD6 | Industrial/Guest Lectures                                   |     |                                    |
| CD7 | Industrial Visits/In-plant Training                         |     |                                    |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |     |                                    |
| CD9 | Simulation  |     |                                    |

**COURSE INFORMATION SHEET**

**Course Code: EC 301**

**Course Title: Digital Communication**

**Pre-requisite(s):** Knowledge of Analog Communication, Probability and Random Signal Theory  
**Co-requisite(s):** NA

**Credits:** L: 3 T: 0 P: 0 C:3

**Class schedule per week: 03**

**Class: B. Tech.**

**Semester / Level: Fifth / Third**

**Branch: Electronics & Communication Engineering**

**Name of Teacher:**

### Course Objectives

This course envisions to impart to students to:

|     |   |
|-----|---|
| 6.  | To know the principles of sampling, Quantization and various waveform coding schemes. |
| 7.  | To learn the various baseband transmission schemes                                    |
| 8.  | To learn the different digital modulation techniques                                  |
| 9.  | To know the elements of information theory  |
| 10. | To know spread spectrum techniques  |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Demonstrate the concept of sampling, Quantization and various waveform coding schemes |
| CO2 | Apply the concepts of various baseband transmission schemes.                          |
| CO3 | Design and develop the different digital modulation systems                           |
| CO4 | Apply the concepts of information theory for digital communication systems            |
| CO5 | Apply the concepts of spread spectrum techniques for digital communication systems    |

### SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b></p> <p>Introduction to digital communication System, Sampling Process, Sampling Theorems for Low Pass and Bandpass Signals, Types of Sampling, Quantization of Signals, Companding, Different Encoding schemes like NRZ, Multilevel Binary, Bi-phase, Differential Manchester, Pulse Code Modulation, Differential Pulse Code Modulation, Delta Modulation and Adaptive Delta Modulation, Noise in Pulse Code Modulation and Delta Modulation Systems.</p> | <p><b>10</b></p>       |
| <p><b>Module – II</b></p> <p>Matched Filter, Error Rate due to Noise, Intersymbol Interference, Nyquist Criterion for Distortion-less Baseband Binary Transmission, Geometric Representation of Signals, The Gram-Schmidt Orthogonalization Procedure, Maximum Likelihood Decoding, Correlation Receiver.</p>   | <p><b>8</b></p>        |
| <p><b>Module – III</b></p> <p>Digital Modulation Techniques: Amplitude Shift Keying, Binary Phase Shift Keying, Differential Phase Shift Keying, Quadrature Phase Shift Keying, M-ary PSK, Binary Frequency Shift Keying, M-ary FSK, and Minimum Shift Keying. Error Probability and Power Spectra of ASK, BPSK, QPSK and BFSK, Equalization Techniques, Synchronization and Carrier Recovery for Digital modulation.</p>   | <p><b>8</b></p>        |
| <p><b>Module – IV</b></p> <p>The concept of Amount of Information, Entropy, Information Rate, Shannon Fano and Huffman Source Coding Schemes, Shannon's theorem, Channel capacity, Capacity of Gaussian Channel, Bandwidth-S/N Trade off</p>  | <p><b>7</b></p>        |
| <p><b>Module – V</b></p> <p>Characteristics and Applications of Spread Spectrum, Direct Sequence Spread Spectrum, Effect of Thermal Noise, Single Tone Interference and Jamming, Code Division Multiple Access, PN Sequence, Frequency Hop Spread Spectrum, Time Hop Spread Spectrum.</p>   | <p><b>7</b></p>        |

**Text Books:**

1. "Principles of Communication Systems", 4/e, by H. Taub and D L Schilling, Goutam Saha, Tata McGraw Hills, ND.
2. "Communication Systems", 4/e by Simon Haykin, John Wiley and Sons, Delhi.
3. "Modern Digital and Analog Communication System" 4/e by B.P.Lathi, Zhi Ding, Oxford University Press

**Reference Books:**

1. Digital Communications Fundamental and Applications by Bernard Sklar, Pearson Education.
2. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.
3. P Ramakrishna Rao, "Digital Communication" TMH Education Private Limited 2011

**Gaps in the Syllabus (to meet Industry/Profession requirements) : NA**

**POs met through Gaps in the Syllabus : NIL**

**Topics beyond syllabus/Advanced topics/Design:**

1. Estimation Theory for Communication System

**POs met through Topics beyond syllabus/Advanced topics/Design Po2, Po3, Po4**

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |   |   |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|---|---|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1                                | 2 | 3 |
| CO1            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 | 3 | 2 | 2  | 1  | 3  | 3                                | 2 | 2 |
| CO2            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 | 3 | 2 | 2  | 1  | 3  | 3                                | 2 | 2 |
| CO3            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 | 3 | 2 | 2  | 1  | 3  | 1                                | 2 | 3 |
| CO4            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 | 3 | 2 | 2  | 1  | 3  | 3                                | 2 | 1 |
| CO5            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 | 3 | 2 | 2  | 1  | 3  | 3                                | 2 | 1 |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of boards/LCD projectors/OHP projectors      | CO1            | CD1, CD 8                   |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1, CD 8 and CD9           |
| CD3     | Seminars  | CO3            | CD1, CD4, CD8 and CD9       |
| CD4     | Mini projects/Projects                                      | CO4            | CD1 and CD8                 |
| CD5     | Laboratory experiments/teaching aids                        | CO5            | CD1 and CD8                 |
| CD6     | Industrial/guest lectures                                   |                |                             |
| CD7     | Industrial visits/in-plant training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL materials and internets |                |                             |

|     |            |  |  |
|-----|------------|--|--|
| CD9 | Simulation |  |  |
|-----|------------|--|--|

## COURSE INFORMATION SHEET

**Course code: EC302**

**Course title: Communication System Lab. Pre-requisite(s): Analog Communication**

**Co- requisite(s): Digital Communication**

**Credits: L: 0 T: 0 P: 3 C: 1.5 Class**

**schedule per week: 03 Class: B. Tech.**

**Semester / Level: Fifth/Three Branch:**

**Electronics & Communication Lab Name**

**of Teacher:**

### Course Objectives:

This course enables the students:

|     |   |
|-----|---|
| 6.  | To develop an understanding about the Analog Modulation Techniques, V-F conversion and Butterworth LPF. |
| 7.  | To develop an understanding about the signal sampling, quantization and its reconstruction              |
| 8.  | To develop an ability to understand and design the various waveform coding techniques                   |
| 9.  | To develop an ability to evaluate and design various digital modulation Techniques                      |
| 10. | To develop an ability to evaluate and design Time Division Multiplexing Technique                       |

### Course Outcomes:

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Demonstrate understanding of the various Analog Modulation Techniques, V-F conversion and Butterworth LPF.            |
| CO2 | Analyse the signal sampling, quantization and its reconstruction.   |
| CO3 | Design the generation and detection of various waveform coding techniques such as PCM, DM and ADM                     |
| CO4 | Design the modulators and demodulators for various digital modulation techniques such as ASK, PSK, FSK, QPSK, and QAM |
| CO5 | Design system for Time Division multiplexing Technique  |

## SYLLABUS

### List of Compulsory experiments:

- 1. Name of the Experiment: Generation and detection of Amplitude Modulated**  
AIM-1: Generation and detection of Amplitude Modulated wave and calculation of percentage modulation using ACL 01 and ACL 02 Kits  
AIM-2: Design of Amplitude Modulation, DSB-SC, and SCB-SC Modulation and Demodulation Systems using ALTAIR Solid Thinking Embed/Comm.
- 2. Name of the Experiment: : Generation and detection of Frequency Modulated wave**  
AIM-1: Generation and detection of Frequency Modulated wave using ACL 03 and ACL 04 FM trainer Kits  
  
AIM-2: Design of Frequency Modulation and Demodulation Systems using ALTAIR Solid Thinking Embed/Comm.
- 3. Name of the Experiment: Generation and detection of PAM, PWM, PPM** AIM-1:  
Generation and detection of PAM, PWM, PPM using DCL 08 Falcon kit.  
  
AIM-2: Design of PAM, PWM, PPM Modulation and Demodulation Systems using ALTAIR Solid Thinking Embed/Comm.
- 4. Name of the Experiment: Design and implementation of 2<sup>nd</sup> and 4<sup>th</sup> order Low pass Butterworth filters**  
AIM-1: Design and implementation of 2<sup>nd</sup> and 4<sup>th</sup> order Low pass Butterworth filters using Multisim  
AIM-2: Design and implementation of 2<sup>nd</sup> and 4<sup>th</sup> order Low pass Butterworth filters
- 5. Name of the Experiment: Investigation of Signal Sampling and Reconstruction** AIM-1:  
Investigation of Signal Sampling and Reconstruction using DCL 01 Falcon kit  
AIM-2: Investigation of Signal Sampling and Reconstruction using ALTAIR Solid Thinking Embed/Comm

6. **Name of the Experiment: Investigation of TDM system** AIM-1: Investigation of TDM system using DCL02 Falcon kit
  
8. **Name of the Experiment: Investigation of practical PCM system**  
AIM-1: Investigation of practical PCM system using DCL03 and DCL04 Falcon kit
  
9. **Name of the Experiment: Investigation of Delta Modulation system**  
AIM-1: Investigation of Delta Modulation and Adaptive Delta modulation system using DCL07 Falcon kit
  
10. **Name of the Experiment: Investigation of ASK, FSK, PSK modulation/demodulation**  
AIM-1: Investigation of ASK, FSK, PSK modulation/demodulation using trainer kits  
  
AIM-2: Design of ASK, PSK, FSK modulator/demodulator using ALTAIR Solid Thinking Embed/Comm
  
9. **Name of the Experiment: Investigation of MSK modulation/demodulation**  
AIM-1: Investigation of MSK modulation/demodulation using trainer kits  
  
AIM-2: Design of MSK modulator/demodulator using ALTAIR Solid Thinking Embed/Comm
  
10. **Name of the Experiment: Investigation of QAM modulation and demodulation** AIM-1 :  
Investigation of QAM modulation and demodulation using ST 2112 QAM trainer kit  
  
AIM-2: Design of QAM modulator/demodulator using ALTAIR Solid Thinking Embed/Comm
  
11. **Name of the Experiment: Investigation of QPSK modulation and demodulation** AIM-1:  
Investigation of QPSK modulation and demodulation using ST 2112 QAM trainer kit  
  
AIM-2: Design of QPSK modulator/demodulator using ALTAIR Solid Thinking Embed/Comm

**Text Book:**

1. “Principles of Communication Systems”, 2/e, by H. Taub and DL Schilling, Tata McGraw Hills, ND.
2. “Communication Systems”, 4/e by Simon Haykin, John Wiley and Sons, Delhi.

**Reference Books:**



1. Simon Haykin, "Communication Systems", Wiley Eastern Limited, New Delhi, 2016, 4/e.
2. J. Schiller, "Mobile Communication" 2/e, Pearson Education, 2012.

**Gaps in the syllabus (to meet Industry/Profession requirements): NA**

**POs met through Gaps in the Syllabus: N/A.**

**Topics beyond syllabus/Advanced topics/Design: N/A**

**POs met through Topics beyond syllabus/Advanced topics/Design: N/A**

**Course Outcome (CO) Attainment Assessment tools & Evaluation procedure**

**Direct Assessment**

| Assessment Tool               | % Contribution during CO Assessment |
|-------------------------------|-------------------------------------|
| <b>Progressive Evaluation</b> | <b>(60)</b>                         |
| Attendance Marks              | <b>12</b>                           |
| Day-to-day performance Marks  | <b>06</b>                           |
| Lab Viva marks                | <b>20</b>                           |
| Lab file Marks                | <b>12</b>                           |
| Lab Quiz-I Marks              | <b>10</b>                           |
| <b>End SEM Evaluation</b>     | <b>(40)</b>                         |
| Lab Quiz-II Marks             | <b>10</b>                           |
| Lab performance Marks         | <b>30</b>                           |

**Indirect Assessment –**

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |   |   |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|---|---|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1                                | 2 | 3 |
| <b>CO1</b>     | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 2  | 1  | 3  | 2                                | 2 | 1 |

|            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <b>CO2</b> | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 2 | 1 | 3 | 2 | 2 | 1 |
| <b>CO3</b> | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 2 | 1 | 3 | 2 | 2 | 1 |
| <b>CO4</b> | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 2 | 1 | 3 | 2 | 2 | 1 |
| <b>CO5</b> | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 2 | 1 | 3 | 2 | 2 | 1 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods:**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD5                           |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1, CD5                           |
| CD3            | Seminars/ Quiz (s)  | CO3                   | CD1, CD5                           |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1, CD5                           |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1, CD5                           |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

## COURSE INFORMATION SHEET

**Course code:** EC303

**Course title:** Microprocessors and

Microcontrollers **Pre-requisite(s):** EC203 Digital  
system Design **Co- requisite(s):**

**Credits:** L: 3 T: 0 P: 0

**Class schedule per week:** 03

**Class:** B.Tech.

**Semester / Level:** V/03

**Branch:** ECE

**Name of Teacher:**

### Course Objectives

|    |   |
|----|---|
| 1. | To explain the basic building blocks of a Microprocessor/ Microcontroller architecture and the operation with relevant timing diagrams.                       |
| 2. | To demonstrate the knowledge of different addressing modes and instruction set of a Microprocessor/ Microcontroller in developing efficient programing logic. |
| 3. | To develop the interfacing circuits for different applications with appropriate peripherals.  |
| 4. | To analyze the evolution of Microprocessor/Microcontroller and compare the different features.  |

|    |  |
|----|--|
| 5. | To design a Microprocessor/ Microcontroller based system suitable for industrial applications. |
|----|--|

### Course Outcomes

After the completion of this course, students shall be able to:

|     |   |
|-----|---|
| CO1 | Define the architectural differences between Microprocessor and Microcontroller.                    |
| CO2 | Apply the programming concepts for the design of efficient codes.                                   |
| CO3 | Make use of different I/O chips for the desired application by programming them in different modes. |
| CO4 | Illustrate the advancements made to the recent generations Microprocessor/ Microcontroller.         |
| CO5 | Develop Microprocessor/ Microcontroller based products to meet the industrial requirements.         |

### SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <b>Module – I</b><br>Review of SAP-I Concept, Introduction to 8085 Microprocessor : Architecture of 8085 Processor , Functions of all signals, Bus concepts, Multiplexed and Demultiplexed Bus, Instruction set, Addressing modes, Stack operation, Timing diagrams, Programming examples, Memory Organization, Memory Interfacing, Memory Mapped I/O, I/O Mapped I/O, Data transfer schemes and Interrupt structure of 8085 Microprocessor.              | <b>10</b>              |
| <b>Module – II</b><br>Introduction to 8086 Microprocessor: Architecture of 8086, concept of pipelining, pin diagram, difference between 8086 and 8088 microprocessor, maximum and minimum modes, Memory organization, advantages of memory segmentation, even and odd addressing of memory, Instruction set, Addressing modes, Stack operation, Timing diagrams, Programming examples, Memory interfacing and interrupt structure of 8086 microprocessor. | <b>10</b>              |

|  |                 |
|--|-----------------|
| <p><b>Module – III</b><br/>Peripheral Interfacing with 8086 Microprocessor: Architecture of 8255 I/O peripheral chip, Modes of operation, Hand shake mode operation, BSR mode, ADC 0801 and ADC 0808 Interfacing with 8086 microprocessor, Analogue multiplexed ADC, DAC 0808 specifications, DAC Interfacing, Programming examples for Generation of square wave, positive and negatives ramps, triangular and sine waves, Sample and Hold circuit, LF 398 and its applications in Data Acquisition. 8253 timer, Modes of operation, Applications, 8279 Keyboard/Display Interface, Different modes of operation, Interfacing, Programming examples</p> | <p><b>7</b></p> |
| <p><b>Module – IV</b><br/>Introduction to advanced Microprocessors: Evolution of Microprocessors, Harvard and Princeton architecture, Concept of CISC and RISC processors Evolutionary steps and Additional features of 80186, 80286, 80386, 80486 and Pentium Processors, Introduction to ARM processors.</p>   | <p><b>5</b></p> |
| <p><b>Module – V</b><br/>Introduction to Microcontrollers: Architecture of 8051, instruction set, interrupt structure of 8051, programming examples, Introduction to 16-bit microcontrollers, Features of 16-bit microcontrollers such as 80196 and PIC24.</p>   | <p><b>8</b></p> |

**Books recommended:**

**Textbooks:**

1. Digital Computer Electronics, 2/e. by A. P. Malvino.
2. Microprocessor Architecture, Programming and Applications with 8085 by R. S. Gaonkar.
3. Advanced Microprocessors and Peripherals by K. M. Bhurchandi and A. K. Ray.
4. The 8051 Microcontroller and Embedded System by Muhammad Ali Mazidi.
5. ARM architecture reference manual, 2/e by David Seal.

**Reference books:**

1. Intel Manual's for 8085, 8086, 8051 and other peripheral chips.
2. Advanced Microprocessor" by Y. Rajasree.
3. Microprocessor and Interfacing, Programming of Hardware" by Douglas Hall.

**Gaps in the syllabus (to meet Industry/Profession requirements):**

**POs met through Gaps in the Syllabus:** N/A

**Topics beyond syllabus/Advanced topics/Design:** N/A

**POs met through Topics beyond syllabus/Advanced topics/Design: N/A**

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| <b>Assessment Tool</b>   | <b>% Contribution during CO Assessment</b> |
|--------------------------|--|
| First Quiz               | 10   |
| Mid Semester Examination | 25   |
| Second Quiz              | 10   |
| Teacher's Assessment     | 5  |
| End Semester Examination | 50   |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| <b>Course Outcome</b> | <b>Program Outcomes (POs)</b> |          |          |          |          |          |          |          |          |           |           |           | <b>Program Specific Outcomes (PSOs)</b> |           |           |
|-----------------------|-------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|---|-----------|-----------|
|                       | <b>1</b>                      | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>6</b> | <b>7</b> | <b>8</b> | <b>9</b> | <b>10</b> | <b>11</b> | <b>12</b> | <b>13</b>                               | <b>14</b> | <b>15</b> |
| <b>CO1</b>            | 3                             | 3        | 2        | 3        | 3        | 1        | 1        |          |          | 3         |           | 3         | 3                                       | 3         | 2         |
| <b>CO2</b>            | 3                             | 3        | 2        | 3        | 3        | 3        | 2        |          |          | 3         |           | 3         | 3                                       | 3         | 2         |
| <b>CO3</b>            | 3                             | 3        | 2        | 3        | 3        | 3        | 2        |          |          | 3         |           | 3         | 3                                       | 3         | 2         |
| <b>CO4</b>            | 3                             | 3        | 2        | 3        | 3        | 2        | 2        |          |          | 3         |           | 3         | 3                                       | 3         | 2         |
| <b>CO5</b>            | 3                             | 3        | 2        | 3        | 3        | 2        | 2        |          |          | 3         |           | 3         | 3                                       | 3         | 2         |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1,CD2 and CD 8                   |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1                                |
| CD3            | Seminars  | CO3                   | CD1, CD2                           |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1 and CD2                        |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1 and CD2                        |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

## COURSE INFORMATION SHEET

**Course code: EC304**

**Course title: Microprocessors and Microcontrollers Lab Pre-requisite(s):**

**Co- requisite(s):**

**Credits:** L: 3 T: 0 P: 0

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: V/ 03**

**Branch: ECE Name**

**of Teacher:**

### Course Objectives

|    |  |
|----|--|
| 1. | To develop efficient 8085 based program for different tasks.   |
| 2. | To develop efficient 8086 based program for different tasks.   |
| 3. | To develop efficient 8051 $\mu$ c based program for different tasks.                                 |
| 4. | To build interfacing circuits for different tasks.   |
| 5. | To be able to develop microprocessor and microcontrollers based systems for industrial applications. |

### Course Outcomes

After the completion of this course, students shall be able to:

|     |  |
|-----|--|
| CO1 | Demonstrate the programming concepts of 8085/8086/8051 for efficient coding.                         |
| CO2 | Show the interfacing of different peripherals with 8085/8086/8051.                                   |
| CO3 | Analyse the output of different peripherals when programmed in different modes using 8085/8086/8051. |
| CO4 | Develop the interfacing circuits for different applications with appropriate peripherals.            |
| CO5 | Design 8085/8086/8051 based system for various real time applications.                               |



## SYLLABUS

Lab is the application of the theory (i.e., hands-on experiments related to the course contents). Therefore, **EC303 Microprocessors and Microcontrollers** is the syllabus for the **EC304 Microprocessors and Microcontrollers Lab**. Following experiments are the guidelines for the students. However, the questions for exams are not limited to this experiment list.

### **List of experiments:**

#### **8085 AND 8086 PROGRAMMING**

##### **1. Name of the Experiment**

###### **Data Transfers**

**Aim1:** REARRANGING BYTES

**Aim2:** GROUPING ODD, EVEN, DIVIDE BY 4 AND DIVIDE BY 16 BYTES

**Aim3:** FORMATION OF A THIRD BLOCK

**Aim4:** FILLING UP 128 LOCATIONS

##### **2. Name of the Experiment**

###### **Arithmetic Operations**

**Aim1:** ADDITION OF 12 BYTES

**Aim2:** MULTIPLICATION OF SINGLE BYTE BY SINGLE BYTE

**Aim3:** ADDITION OF 18 BCD NO'S **Aim4:**

ADDITION OF TWO 10-BYTE NO'S

**Aim5:** ADDITION OF TWO 20-DIGIT BCD NO's:

**Aim6:** BCD SUBTRACTION

**Aim7:** MULTIPLICATION OF TWO 5-BYTE BINARY NUMBERS

**Aim8:** BCD MULTIPLICATION

**Aim9:** BINARY DIVISION

##### **3. Name of the Experiment**

###### **Logical Operations**

**Aim1:** CHECKING BITS OF A WORD

**Aim2:** LOGICAL OPERATION

##### **4. Name of the Experiment**

###### **Data Processing**

**Aim1:** NUMBER OF BITS IN BYTES

**Aim2:** MAXIMUM AND MINIMUM BYTES

**Aim3:** SIZE OF A BLOCK ENDING WITH A SPECIFIED BYTE

**Aim4:** SIZE OF A BLOCK STARTING WITH 00H AND ENDING WITH 60H

**Aim5:** SIZE OF A BLOCK ENDING WITH THREE ALTERNATE 00H

**Aim6:** NUMBER OF TIMES FFH OCCURS AS PAIR

**Aim7:** CONSECUTIVE MEMORY LOCATIONS WITH IDENTICAL DATA

**Aim8:** COUNT OF SPECIFIED BYTES

**Aim9:** ADDRESS OF LAST NON-BLANK CHARACTER

**Aim10:** REPLACING TRAILING ZEROS WITH BLANKS  
**Aim11:** ADDING EVEN PARITY TO ASCII CHARACTERS

**5. Name of the Experiment**

**Sorting**

**Aim1:** SORTING IN DESCENDING ORDER  
**Aim2:** SORTING EVEN AND ODD PARITY BYTES  
**Aim3:** SORTING SIGNED BYTES  
**Aim4:** SORTING SIGNED BINARY BYTES IN ASCENDING ORDER

**6. Name of the Experiment**

**String Operations**

**Aim1:** COMPARISON OF TWO ASCII STRINGS  
**Aim2:** AN ASCII STRING TO BYTE CONVERSION  
**Aim3:** INSERTION TO A LIST

**7. Name of the Experiment**

**Parallel Communication**

**Aim1:** WRITE AN ASSEMBLY LANGUAGE PROGRAM FOR GENERATION OF SQUARE WAVE USING 8255.

**Aim2:** WRITE AN ASSEMBLY LANGUAGE PROGRAM FOR INPUTTING AN 8-BIT DATA THROUGH PORT A OF 8255 IN MODE – 0

**Aim3:** WRITE AN ASSEMBLY LANGUAGE PROGRAM FOR INPUTTING AN 8-BIT DATA THROUGH PORT A OF 8255 IN MODE – 1 THROUGH STATUS CHECK.

**Aim4:** WRITE AN ASSEMBLY LANGUAGE PROGRAM FOR GENERATION OF SQUARE WAVE USING 8253.

**Aim5:** WRITE AN ASSEMBLY LANGUAGE PROGRAM TO GENERATE TRIANGULAR WAVE USING DAC 0808.

**Aim6:** WRITE AN ASSEMBLY LANGUAGE PROGRAM TO GENERATE SAW TOOTH WAVE OF MAGNITUDE 0 VOLT TO +4 VOLTS USING DAC 0808.

**Aim7:** WRITE AN ASSEMBLY LANGUAGE PROGRAM TO CONVERT ANALOG SIGNALS OF MAGNITUDE +3.5 VOLTS TO +5 VOLTS IN STEPS OF 0.1 VOLTS TO DIGITAL EQUIVALENT HEX VALUES.

**Aim8:** WRITE AN ASSEMBLY LANGUAGE PROGRAM TO CONTROL THE SPEED OF STEPPER MOTOR USING 8255 PPI.

**Aim9:** WRITE AN ASSEMBLY LANGUAGE PROGRAM TO CONTROL THE TRAFFIC LIGHTS USING 8255 PPI

**8. Name of the Experiment**

**Serial Communication**

**Aim1:** WRITE AN ASSEMBLY LANGUAGE PROGRAM FOR GENERATION OF SQUARE WAVE USING SERIAL OUTPUT PIN

**Aim2:** WRITE AN ASSEMBLY LANGUAGE PROGRAM FOR INPUTTING AN 8-BIT DATA SERIALLY THROUGH SERIAL INPUT PIN.

**9. Name of the Experiment**

**Interrupts**

**Aim1:** To study the software and hardware interrupts of 8085.

**Aim2:** To study the Interrupt controller 8259.

**Aim3:** To study the Interrupt features of 8051.

#### **10. Name of the Experiment Timers**

**Aim1:** WRITE AN ASSEMBLY LANGUAGE PROGRAM TO CALCULATE THE CONVERSION TIME OF ADC USING 8253 TIMER.

**Aim2:** WRITE AN ASSEMBLY LANGUAGE PROGRAM TO OBSERVE WAVEFORMS OF 8253 TIMER IN DIFFERENT MODES.

#### **11. Name of the Experiment**

##### **Keyboard and Display**

**Aim1:** WRITE AN ASSEMBLY LANGUAGE PROGRAM TO FLASH AND ROTATE “HELP US” USING 8259 PIC.

#### **12. Name of the Experiment**

##### **Code Conversion**

**Aim1:** BINARY TO BCD CONVERSION

**Aim2:** BCD TO BINARY CONVERSION

**Aim3:** CONVERSION OF NIBBLES TO ASCII CODES **Aim4:**

ASCII TO HEXADECIMAL CONVERSION

#### **Books recommended:**

#### **Textbooks:**

6. Microprocessor Architecture, Programming and Applications with 8085 by R. S. Gaonkar.
7. Advanced Microprocessors and Peripherals by K. M. Bhurchandi and A. K. Ray.
8. The 8051 Microcontroller and Embedded System by Muhammad Ali Mazidi.

#### **Reference books:**

4. Intel Manual’s for 8085, 8086, 8051 and other peripheral chips.
5. Advanced Microprocessor” by Y. Rajasree.
6. Microprocessor and Interfacing, Programming of Hardware” by Douglas Hall.

#### **Gaps in the syllabus (to meet Industry/Profession requirements):**

**POs met through Gaps in the Syllabus:** N/A.

#### **Topics beyond syllabus/Advanced topics/Design:**

**POs met through Topics beyond syllabus/Advanced topics/Design:**

## Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

### Direct Assessment

| Assessment Tool                | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | (60)                                |
| Attendance Marks               | 10                                  |
| Lab file Marks                 | 06                                  |
| Day-to-day performance Marks   | 44                                  |
| <b>End SEM Evaluation</b>      | <b>(40)</b>                         |
| Lab quiz Marks                 | 08                                  |
| Lab Viva marks                 | 12                                  |
| Lab performance Marks          | 20                                  |

### Indirect Assessment

1. Student Feedback on Course

Gaps in the syllabus (to meet Industry/Profession requirements): N/A

POs met through Gaps in the Syllabus: N/A

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

## Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

### Direct Assessment

| Assessment Tool               | % Contribution during CO Assessment |
|-------------------------------|-------------------------------------|
| <b>Progressive Evaluation</b> | <b>(60)</b>                         |
| Attendance Marks              | 10                                  |
| Lab file Marks                | 06                                  |
| Day-to-day performance Marks  | 44                                  |
| <b>End SEM Evaluation</b>     | <b>(40)</b>                         |
| Lab quiz Marks                | 08                                  |
| Lab Viva marks                | 12                                  |
| Lab performance Marks         | 20                                  |

## Indirect Assessment –

### 1. Student Feedback on Course Outcome

## Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 |   |   | 2  |    | 2  | 2                                | 2  | 1  |
| CO2            | 3                      | 3 | 2 | 3 | 3 | 3 | 2 |   |   | 2  |    | 2  | 2                                | 2  | 1  |
| CO3            | 3                      | 3 | 2 | 3 | 3 | 3 | 2 |   |   | 2  |    | 2  | 2                                | 2  | 1  |
| CO4            | 3                      | 3 | 2 | 3 | 3 | 2 | 2 |   |   | 2  |    | 2  | 2                                | 2  | 1  |
| CO5            | 3                      | 3 | 2 | 3 | 3 | 2 | 2 |   |   | 2  |    | 2  | 2                                | 2  | 1  |

## Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

| Mapping Between COs and Course Delivery (CD) methods |   |                |                        |
|--|---|----------------|------------------------|
| CD   | Course Delivery methods                                     | Course Outcome | Course Delivery Method |
| CD1  | Lecture by use of boards/LCD projectors/OHP projectors      | CO1            | CD5, CD9               |
| CD2  | Tutorials/Assignments/Quiz (s)                              | CO2            | CD5, CD9               |
| CD3  | Seminars  | CO3            | CD5, CD9               |
| CD4  | Mini projects/Projects                                      | CO4            | CD5, CD9               |
| CD5  | Laboratory experiments/teaching aids                        | CO5            | CD5, CD9               |
| CD6  | Industrial/guest lectures                                   |                |                        |
| CD7  | Industrial visits/in-plant training                         |                |                        |
| CD8  | Self- learning such as use of NPTEL materials and internets |                |                        |

|     |            |  |  |
|-----|------------|--|--|
| CD9 | Simulation |  |  |
|-----|------------|--|--|

### COURSE INFORMATION SHEET

**Course Code: EC 305**

**Course Title: Signal Processing Techniques**

**Pre-requisite(s): Signals and Systems Co-requisite(s):**

**Credits:** L: 3 T: 1 P: 0

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: 5**

**Branch: Electronics and Communication Engineering Name of Teacher:**

#### Course Objectives

This course envisions to impart students to:

|   |   |
|---|---|
| 1 | Understand the basic concepts of signals and system in frequency and Z- domain. |
| 2 | Develop transfer function, and structure of digital systems.                    |
| 3 | Develop an ability to design and apply analog filters.                          |
| 4 | Design and implement the digital FIR and IIR filters.                           |
| 5 | Understand the multi-rate signal processing and spectrum estimation.            |

#### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Study the system representation and characteristics in frequency and Z-transform Domain. |
| CO2 | Design and implement the digital system structures and analyse them.                     |
| CO3 | Design of analog filters Butterworth filter, Chebyshev filter for various applications.  |
| CO4 | Design of digital FIR and IIR filters for various applications.                          |
| CO5 | Implement multi rate signal processing and spectral estimation.                          |

## SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <p><b>Module – I</b></p> <p>Introduction to Discrete-Time Signals and system, concept of frequency in continuous and discrete time signal, LTI system as frequency selective filter, Inverse system and de-convolution, Discrete Time Fourier Transform (DTFT) and Discrete Fourier Transform (DFT), Periodic convolution, Direct evaluation of DFT, FFT algorithms- decimation in time and frequency, Z-transform, Analysis of LTI system in Z-domain, Relationship between Laplace and Ztransforms, Relationship between Fourier and Z-transforms.</p> | <b>10</b>              |
| <p><b>Module – II</b></p> <p>Digital Filter Structures (FIR &amp; IIR): Direct form I&amp;II, cascade, parallel and ladder realizations, lattice structure, representation of numbers, quantization of filter coefficients, round-off effects.</p>   | <b>8</b>               |
| <p><b>Module – III</b></p> <p>Filter Function Approximations and Transformations.</p> <p>Review of approximations of ideal analog filter response, Butterworth filter, Chebyshev Type I &amp; II, Elliptic filters. Frequency Transformations: Frequency transformation in analog domain, frequency transformation in digital domain.</p>  | <b>8</b>               |

|   |          |
|---|----------|
| <p><b>Module – IV</b><br/> Design of IIR Filter: Design based on analog filter approximations, Impulse invariance method, Matched Z-transformation, Bilinear transformation. Design of FIR Filters: Symmetric and antisymmetric FIR filters, design of linear phase FIR filters using windows and frequency – sampling methods, design of optimum equiripple linear phase FIR filters, comparison of FIR and IIR filters.</p> | <b>8</b> |
| <p><b>Module – V</b><br/> Multi rate DSP, Decimators and Interpolators, Sampling rate conversion, multistage decimator &amp; interpolator, Poly phase filters, Estimation of Spectra from Finite-Duration Observations of Signals.</p>  | <b>6</b> |

**Text Books:**

1. John G. Proakis, Dimitris G. Mamalakis, Digital Signal Processing, Principles, Algorithms and Applications
2. Alan V. Oppenheim Ronald W. Schaffer, Digital Signal Processing, PHI, India.
3. S. K. Mitra - Digital Signal Processing: A computer based approach, TMH, 2001

**Reference Books:**

1. Antonious, Digital Filter Design, Mc-Graw-Hill International Editions.

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

1. Applications of signal processing techniques through hardware platform.

**POs met through Gaps in the Syllabus**

NA

**Topics beyond syllabus/Advanced topics/Design**

DSP Processor architectures

**POs met through Topics beyond syllabus/Advanced topics/Design**

2

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool | % Contribution during CO Assessment |
|-----------------|-------------------------------------|
|-----------------|-------------------------------------|



|                          |    |
|--------------------------|----|
| First Quiz               | 10 |
| Mid Semester Examination | 25 |
| Second Quiz              | 10 |
| Teacher's Assessment     | 5  |
| End Semester Examination | 50 |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 |   | 2 | 1 |   |   |   | 1 | 1  | 1  | 2  |                                  |    |    |
| CO2            | 3                      | 3 |   | 2 | 2 |   |   |   | 1 | 2  | 1  | 2  |                                  |    |    |
| CO3            | 2                      | 3 |   | 2 | 3 |   |   |   | 1 | 1  | 1  | 2  |                                  |    |    |
| CO4            | 3                      | 3 |   | 2 | 3 |   |   |   | 1 | 1  | 1  | 2  |                                  |    |    |
| CO5            | 3                      | 2 | 1 | 1 | 2 |   |   |   | 1 | 1  | 1  | 2  |                                  |    |    |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD7, CD 8              |
| CD2     | Tutorials/Assignments                   | CO2            | CD1 and CD9                 |

|     |   |     |                  |
|-----|---|-----|------------------|
| CD3 | Seminars  | CO3 | CD1, CD2 and CD3 |
| CD4 | Mini Projects/Projects                                      | CO4 | CD1 and CD2      |
| CD5 | Laboratory Experiments/Teaching Aids                        | CO5 | CD1 and CD2      |
| CD6 | Industrial/Guest Lectures                                   |     |                  |
| CD7 | Industrial Visits/In-plant Training                         |     |                  |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |     |                  |
| CD9 | Simulation  |     |                  |

### COURSE INFORMATION SHEET

**Course Code: EC 306**

**Course Title: Signal Processing Lab**

**Pre-requisite(s): Signals & Systems Co-requisite(s):**

**Credits:** L: 3 T: 1 P: 0

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: 5**

**Branch: Electronics and Communication Engineering Name of Teacher:**

#### Course Objectives

This course envisions to impart students to:

|   |  |
|---|--|
| 1 | Understand the basics of Signal Processing algorithms such as convolution and correlation via MATLAB implementation. |
|---|--|

|   |  |
|---|--|
| 2 | Design system and analyse its characteristics in transform domain.     |
| 3 | Design of FIR and IIR filters.   |
| 4 | Develop skill for MATLAB code and its implementation in DSP processor. |
| 5 | Apply the signal Processing techniques in various applications.        |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Demonstrate understanding of MATLAB with signal processing perspective.     |
| CO2 | Design digital system and analyse its characteristics in transform domain.  |
| CO3 | Design and implement FIR and IIR filters.                                   |
| CO4 | Apply the knowledge of MATLAB to various set of signal processing problems. |
| CO5 | Develop and apply the signal Processing Algorithms in various applications. |

### SYLLABUS

| Experiments | (NO. OF<br>Sessional<br>Classes) |
|-------------|----------------------------------|
|             |                                  |

|  |                  |
|--|------------------|
| <p><b>List of Compulsory experiments:</b></p> <ol style="list-style-type: none"> <li>1. Familiarization with MATLAB. Generation of the following sequence and to plot them using MATLAB:             <ol style="list-style-type: none"> <li>a. Unit Sample Sequence <math>\delta[n]</math></li> <li>b. Unit Step Sequence <math>u[n]</math></li> <li>c. Ramp Sequence <math>n \cdot u[n]</math></li> <li>d. Exponential Sequences</li> <li>e. Sine / Cosine Sequences</li> </ol> </li> <li>2. To generate the discrete time signal from analog signal using sampling theorem and analyse the aliasing effect.</li> <li>3. Verification of the following general properties of LTI system.             <ol style="list-style-type: none"> <li>a. Linearity</li> <li>b. Time-invariance</li> </ol> </li> <li>4. Computation of the linear convolution of two finite-length sequences. Compare your result with that obtained by theoretical evaluation.</li> <li>5. To compute the auto correlation/cross-correlation of two finite-length sequences. Compare your result with that obtained by theoretical evaluation.</li> <li>6. Obtain Inverse Z-Transforms using the Partial Fraction Expansion and test its stability.</li> <li>7. Cascade realization of the Linear-Phase FIR/ IIR transfer functions using MATLAB.</li> <li>8. Find out the output of two Periodic Digital sequences using Circular Convolution. Compare your result with that obtained by theoretical evaluation.</li> <li>9. Computation of N-point DFT and FFT of the length-N sequence using MATLAB and implement using TMS DSP processor.</li> <li>10. Design of digital filter (LP/HP/BP) and evaluate its performance.</li> <li>11. To realize the decimation, interpolation and sampling rate conversion of a signal.</li> <li>12. To write a program and simulate using C language / assembly language for computation of Linear Convolution using TMS DSP Processor</li> </ol> | <p><b>12</b></p> |
| <p><b>List of Optional experiments:</b></p> <ol style="list-style-type: none"> <li>1. To develop a MATLAB program to convert Analog to Digital Frequencies using Bilinear Transformation.</li> <li>2. To design a Butterworth filter using standard design steps (for LP, HP, BP &amp; BR filters), i.e. find out the order of the filter when Pass Band Gain, Sampling frequency and Pass Band and Stop Band Cut-Off frequencies are given. Then find out the Normalized Transfer Function and Actual Transfer Function</li> <li>3. To design a Chebyshev filter using standard design steps (general programs for LP, HP, BP &amp; BR filter design)</li> </ol>  | <p><b>8</b></p>  |

**Text Books:**

1. Getting Started with MATLAB by RudraPratap, Oxford Publication

2. Digital Signal Processing: A computer-Based Approach by Sanjit K. Mitra, Mc-graw Hill
3. Digital Signal Processor: Architecture, Programming and Applications by B. Venkataramani and M. Bhaskar, Tata Mc-graw Hill

**Reference Books:**

1. Digital Signal Processing using Matlab by Vinay K. Ingle and John J. Proakis, Cengage Learning.

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

NA

**POs met through Gaps in the Syllabus**

**Topics beyond syllabus/Advanced topics/Design**

Through experiments involving design/modelling of device/circuits on advanced topics

**POs met through Topics beyond syllabus/Advanced topics/Design**

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool              | % Contribution during CO Assessment |
|------------------------------|-------------------------------------|
| Progressive Evaluation       | (60)                                |
| Attendance Marks             | 12                                  |
| Lab file Marks               | 12                                  |
| Viva Marks                   | 24                                  |
| Day-to-day performance Marks | 12                                  |
| End SEM Evaluation           | (40)                                |
| Lab quiz Marks               | 20                                  |
| Lab performance Marks        | 20                                  |

## Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 1                      | 2 |   | 3 | 3 |   |   |   | 1 | 2  |    | 3  |                                  |    |    |
| CO2            | 2                      | 2 |   | 3 | 3 |   |   |   | 1 | 2  |    | 3  |                                  |    |    |
| CO3            | 2                      | 2 |   | 3 | 3 |   |   |   | 1 | 2  |    | 3  |                                  |    |    |
| CO4            | 1                      | 2 |   | 3 | 3 |   |   |   | 1 | 2  |    | 3  |                                  |    |    |
| CO5            | 1                      | 2 |   | 3 | 3 |   |   |   | 1 | 2  |    | 3  |                                  |    |    |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD5                         |
| CD2     | Tutorials/Assignments                                       | CO2            | CD5                         |
| CD3     | Seminars  | CO3            | CD5                         |
| CD4     | Mini Projects/Projects                                      | CO4            | CD5                         |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD5                         |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9     | Simulation  |                |                             |

## COURSE INFORMATION SHEET

Course code: **EC307**

Course title: **Fundamentals of Data communication**

Pre-requisite(s): **basic concepts of communication** Co-requisite(s):

Credits: L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B.E

Semester / Level: VI

Branch: ECE

Name of Teacher:

### **Course Objectives:**

This course enables the students:

|    |   |
|----|---|
| A. | To build an understanding of the fundamental concepts of Data Communication   |
| B. | To analyze the performance of different flow control and error control mechanism and implement Error detection and correction scheme. |
| C. | Find out a suitable multiplexing scheme for effective utilization of the bandwidth.   |
| D. | Implement different routing algorithm on a given network  |
| E. | To justify the need of protocol and standards in data communication   |

### **Course Outcomes:**

After the completion of this course, students will be:

|     |   |
|-----|---|
| CO1 | Understand the basic concepts of data encoding and data transmission.   |
| CO2 | Explain different Data link control techniques like, error detection, correction, flow control and error control. |
| CO3 | Demonstrate different multiplexing schemes and their practical application.                                       |
| CO4 | Compare the performance of different switching techniques.  |
| CO5 | Define the protocols and standards used in data communication   |

## SYLLABUS

| <b>MODULE</b>   | <b>(NO. OF LECTURE HOURS)</b> |
|---|-------------------------------|
| <b>Module – I</b><br>Data Communication Techniques:: Basic Concepts, Analog and Digital Transmission, Transmission line Impairments, Channel Capacity, Guided Transmission media, Digital data to Digital Signal, Different encoding schemes like NRZ, Multilevel Binary, Bi phase, Differential Manchester, Scrambling techniques, Self clocking codes, CODEC and MODEM. Synchronous and Asynchronous transmission, Backward and Forward Error Control, Error detection techniques like CRC, Shift register implementation, Error correction, Block Code principles, Hamming distance, Interfacing standards like V.24/EIA-232.F, CCITT-X.21 Interface | <b>9</b>                      |
| <b>Module – II</b><br>Data Link Control: Line Configurations, Flow Control using Stop and Wait ARQ, Sliding window protocol, Error control using Stop and Wait ARQ, Go-back-to N ARQ, Selective Reject ARQ, Data Link Control Protocol HDLC, Basic characteristics, Frame structure and operation of HDLC, Data transparency control using bit stuffing, Utilization efficiency of a link, Point-to-Point Protocol (PPP), Introduction to LCP, PAP, CHAP, NCP and IPCP.   | <b>9</b>                      |



|   |                 |
|---|-----------------|
| <p><b>Module – III</b></p> <p>Multiplexing and switched Network Frequency Division Multiplexing, Carrier standards, Synchronous Time Division Multiplexing, TDM link control, Digital Carrier systems, SONET/SDH, Statistical Time Division Multiplexing, Performance, Cable Modem, ADSL Design, Discrete multitone, xDSL.</p> <p>Comparison of Circuit switching, Message switching and Packet switching techniques, Digital switching concepts like Space division switching, 3-Stage Space division switch, Control Signalling, Common-channel Signalling, TDM Bus switch, TSI switch, Time Multiplexed Switches like STS and TST, Routing in circuit switched networks.</p> | <p><b>8</b></p> |
| <p><b>Module – IV</b></p> <p>Packet Switching: Datagram packet switching and Virtual circuit Packet switching, Use of Least cost algorithms like Dijkstra’s and Bellman-Ford algorithms, Routing characteristics, Routing strategies, Example system of ARPANET (all 3 generations) Congestion, Congestion control techniques, Traffic management, Congestion control in Packet switched networks, CCITT X.25 Interface.</p>  | <p><b>7</b></p> |
| <p><b>Module – V</b></p> <p>Protocols : The need for a Protocol Architecture, OSI layered structure, TCP/IP Protocol Suite, Fundamental differences between OSI and TCP/IP, Primitives and PDUs. LAN protocol architecture, Function of LLC and MAC. Connecting devices like Repeaters, Hubs, Bridges, Two-layer switches, Routers and Three layer switches. IP header and IP addressing. Transport protocols TCP and UDP.</p>  | <p><b>7</b></p> |

**Text Books:**

1. Data and Computer Communication, 7/e. by William Stallings.
2. Data Communication and Networking, 3/e. by Behrouz. A. Forouzan.

**Reference Books:**

1. Data Communication and Computer Networks by Prakash C. Gupta. Prentice Hall India Pvt., Limited

### Gaps in the Syllabus (to meet Industry/Profession requirements)

Hardware implementation and testing of encoding techniques, link layer protocols, multiplexing techniques.

#### POs met through Gaps in the Syllabus

3, 4, 12

#### Topics beyond syllabus/Advanced topics/Design

- Network Security
- Application Layer protocol

#### POs met through Topics beyond syllabus/Advanced topics/Design

2, 3, 4, 12

### Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

#### Direct Assessment

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

#### Indirect Assessment

1. Students' Feedback on Course Outcome.

#### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 1 | 1 | 2 | 1 | - | - | - | - | -  | -  | 2  | 2                                | 1  | 3  |

|            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <b>CO2</b> | 3 | 3 | 3 | 2 | 1 | - | - | - | - | - | - | 1 | 3 | 1 | 3 |
| <b>CO3</b> | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 2 | 2 | 2 |
| <b>CO4</b> | 3 | 2 | 1 | 1 | 1 | - | - | - | - | - | - | 1 | 2 | 2 | 2 |
| <b>CO5</b> | 3 | 1 | 1 | 2 | 1 | - | - | - | - | - | - | 2 | 2 | 1 | 3 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD7, CD 8                     |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1 and CD9                        |
| CD3            | Seminars  | CO3                   | CD1, CD2 and CD3                   |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1 and CD2                        |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1 and CD2                        |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

### **COURSE INFORMATION SHEET**

**Course Code: EC 309**

**Course Title: Adaptive Signal Processing**

**Pre-requisite(s): Signals and Systems Co-requisite(s):**

**Credits:**        L: 3    T: 1    P: 0

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: 5**

**Branch: Electronics and Communication Engineering Name of Teacher:**

### **Course Objectives**

This course envisions to impart students to:

|     |   |
|-----|---|
| 11. | Understand the concept of adaptive systems and its characteristics. |
|-----|---|

|     |   |
|-----|---|
| 12. | Impart knowledge on adaptive algorithms LMS and RLS.                      |
| 13. | Impart knowledge on adaptive filter for optimal control.                  |
| 14. | Demonstrate the concept of adaptive beam forming and array system.        |
| 15. | To help to design and apply adaptive filters for real- time applications. |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Demonstrate the adaptive systems and its characteristics and LMS algorithm.   |
| CO2 | Apply and analyse the RLS algorithms, lattice filters and Kalman filter.  |
| CO3 | Design and implement adaptive control techniques.   |
| CO4 | Implement the adaptive array and beam forming techniques in engineering applications.   |
| CO5 | Design and evaluate adaptive filters for adaptive noise cancellation, adaptive line enhancement and interference cancellation, prediction considering present day challenges and recent research development. |

### SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <b>Module – I</b><br>Introduction to adaptive systems - definitions and characteristics, Adaptive linear combiner : input signal and weight vector, the performance function, gradient and minimum mean square error, alternative expression of gradient, LMS, NLMS, sign-error, sign-data and FXLMS algorithms, transform domain LMS. | <b>8</b>               |

|   |          |
|---|----------|
| <p><b>Module – II</b></p> <p>Recursive least square algorithm, windowed RLS, computational complexity, Block adaptive filter (time and DFT domains), adaptive lattice filters, Adaptive filters with Orthogonal signals, Kalman Filter.</p>   | <b>8</b> |
| <p><b>Module – III</b></p> <p>Adaptive model control, Adaptive inverse control and model reference controls. Plant noise and the filtered-X LMS Algorithm, Inverse control using Filtered-X LMS algorithm.</p>  | <b>8</b> |
| <p><b>Module – IV</b></p> <p>Adaptive array and adaptive beam forming: Sidelobe cancellation, Beam forming with a Pilot signal, Narrowband experiments , Broadband experiments, Characteristics of receiving arrays, Griffiths LMS Beamformer, Adaptive beamformer with pole and zeros, signal cancellation and distortion.</p> | <b>8</b> |
| <p><b>Module – V</b></p> <p>Applications of Adaptive Filters: Adaptive Noise Cancellation, Adaptive Line Enhancement, System identification, Channel equalization, Cancelling antenna sidelobe Interference, Adaptive self tuning filter.</p>   | <b>8</b> |

**Text Books:**

1. B.Widrow and S. D. Sterns, Adaptive Signal Processing, Pearson Education, 2nd Indian reprint, 2002.
2. D. G. Manolokis, V. K. Ingle and S. M. Kogar, “Statistical and Adaptive Signal Processing”, Mc Graw Hill International Edition, 2000.
3. S. Haykin and T. Kailath, Adaptive Filter Theory, Pearson Education, 4th Edition, 2005.

**Reference Books:**

1. Digital Signal Processing 3/E by S.K.Mitra TMH Edition.
2. Fundamentals of adaptive filtering, A. H. Sayed, Wiley, 2003.
3. Monson H. Hayes, Statistical Digital Signal Processing and Modelling, Wiley, 2002

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

2. Applications of adaptive signal processing techniques through hardware platform.

**POs met through Gaps in the Syllabus**

NA

## Topics beyond syllabus/Advanced topics/Design

DSP Processor architectures

## POs met through Topics beyond syllabus/Advanced topics/Design

2

## Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

### Direct Assessment

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

## Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 |   | 2 | 1 |   |   |   | 1 | 1  | 1  | 2  |                                  |    |    |
| CO2            | 3                      | 3 |   | 2 | 2 |   |   |   | 1 | 2  | 1  | 2  |                                  |    |    |
| CO3            | 2                      | 3 | 1 | 1 | 3 |   |   |   | 1 | 1  | 1  | 2  |                                  |    |    |
| CO4            | 3                      | 3 |   | 2 | 3 |   |   |   | 1 | 1  | 1  | 2  |                                  |    |    |
| CO5            | 3                      | 2 | 1 | 1 | 2 |   |   |   | 1 | 1  | 1  | 2  |                                  |    |    |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD7, CD 8                     |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1 and CD9                        |
| CD3            | Seminars  | CO3                   | CD1, CD2 and CD3                   |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1 and CD2                        |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1 and CD2                        |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

**COURSE INFORMATION SHEET**

**Course Code: EC 311**

**Course Title: DSP Processor Pre-requisite(s): Signals and Systems Co-requisite(s):**

**Credits:**        L: 3    T: 1    P: 0

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: 5**

**Branch: Electronics and Communication Engineering Name of Teacher:**

**Course Objectives**

This course envisions to impart students to:

|    |  |
|----|--|
| 1. | Understand the real time signal processing with hardware.                        |
| 2. | Explain the architectures of DSP and General Purpose Processors.                 |
| 3. | Learn to develop code on code Composer Studio.                                   |
| 4. | Write the real time DSP algorithm for real time signal using Processing.         |
| 5. | Apply the concept of the signal processing to understand the programming skills. |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Demonstrate understanding on the real time signal processing with hardware and software |
| CO2 | Compare the architectures of DSP and General Purpose Processors.                        |
| CO3 | Demonstrate understanding of DSP Instruction Set and Assembly Language Programming      |
| CO4 | Implement and evaluate the DSP algorithms in code composer studio.                      |
| CO5 | Develop the DSP algorithm for processing of real time signal using DSP Processor.       |

### SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <b>Module – I</b><br>Introduction – DSP Tasks and Applications, Real-time Signal Processing, Representation of DSP algorithms; Number Representations and Arithmetic Operations - Fixed point and floating-point representations and arithmetic operations; Q notation | <b>8</b>               |



|  |          |
|--|----------|
| <p><b>Module – II</b></p> <p>Typical DSP Hardware: Digital Signal Processor Architectures – CPU, Peripherals; Specific DSP processor architecture; Introduction to DSP systems and architecture; Texas Instruments family of DSP Processors, study of TMS320C6713/6416 Processor’s architecture.</p>   | <b>8</b> |
| <p><b>Module – III</b></p> <p>DSP Instruction Set and Assembly Language Programming – Instruction types; Parallel programming; Pipelining; Efficient programming; Arithmetic: Fixed point, floating point and residue arithmetic, Cordic architectures.</p>  | <b>8</b> |
| <p><b>Module – IV</b></p> <p>Extensive parallel operations, MAC operations, different addressing techniques, common instructions used for extensive DSP applications, familiarity with Code Composer Studio.</p>   | <b>8</b> |
| <p><b>Module – V</b></p> <p>DSP Algorithms and their Efficient Implementation - a) Linear filtering; b) FFT and spectrum analysis; c) Scalar and vector quantization, source coding, linear prediction coding; d) Function generation; Software Design for Low Power Consumption. Software Configurable processors, Application case studies in multimedia compression and communication</p> | <b>8</b> |

**Text Books:**

1. Rulph Chassaing, “Digital Signal Processing and Applications with the C6713 and C6416 DSK”, Wiley, 2005
2. U. Meyer Baesse, “Digital Signal Processing with FPGAs”, Springer, 2001

**Reference Books:**

1. Behrooz Parhami, “Computer Arithmetic Algorithms and Hardware Design”, Oxford, 2000.
2. Shehrzad Qureshi, “Embedded Image Processing on the TMS320C6000 DSP” Springer, 2005.

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

NA

**POs met through Gaps in the Syllabus**

PO8 will be met though report-writing/presentation-based assignment

## Topics beyond syllabus/Advanced topics/Design

Teaching through research paper

## POs met through Topics beyond syllabus/Advanced topics/Design

### Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

#### Direct Assessment

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

#### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 |   | 2 | 1 |   |   |   | 1 | 1  | 1  | 2  |                                  |    |    |
| CO2            | 3                      | 3 |   | 2 | 2 |   |   |   | 1 | 2  | 1  | 2  |                                  |    |    |
| CO3            | 2                      | 3 | 1 | 1 | 3 |   |   |   | 1 | 1  | 1  | 2  |                                  |    |    |
| CO4            | 3                      | 3 |   | 2 | 3 |   |   |   | 1 | 1  | 1  | 2  |                                  |    |    |
| CO5            | 3                      | 2 | 1 | 1 | 2 |   |   |   | 1 | 1  | 1  | 2  |                                  |    |    |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD7, CD 8                     |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1 and CD9                        |
| CD3            | Seminars  | CO3                   | CD1, CD2 and CD3                   |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1 and CD2                        |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1 and CD2                        |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

**COURSE INFORMATION SHEET**

Course code: **EC312**

Course title: **Digital Signal Processor Lab**

Pre-requisite(s): EC311 Digital Signal Processor

Co- requisite(s): EC305 Signal Processing Techniques

Credits:        L: 0    T: 0    P: 3

Class schedule per week: 03 Class:

B. Tech.

Semester / Level: V

Branch: ECE

Name of Teacher:

## Course Objectives

This course enables the students to:

|    |  |
|----|--|
| 1. | Develop concept to process the signal with the help of DSP processor   |
| 2. | Demonstrate the concept of signal processing algorithm to implement in DSP processor.                                |
| 3. | Understand the architecture of DSP Processor and development of programming concept.                                 |
| 4. | Grasp how to develop signal processing using Code composer studio to build a dedicated hardware for particular work. |
| 5. | To elaborate the real time signal processing to control real time system   |

## Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Apply the concept of DSP processor to implement signal operation.   |
| CO2 | Illustrate the concept of signal processing algorithm to implement in DSP processor.  |
| CO3 | Explain the architecture of DSP Processor and development of programming concept.   |
| CO4 | Implement signal processing algorithm using Code composer studio to build a dedicated DSP processor hardware for particular work. |
| CO5 | Develop real time signal processing-based inference and decision system   |

## Syllabus

This Lab is the application of the theory (i.e., hands-on experiments related to the course contents). Therefore, EC311 Digital Signal Processor is the syllabus for the EC312 Digital Signal Processor Lab. Following experiments are the guidelines for the students. However, the questions for exams are not limited to these experiments.

### List of experiments:

1. To study the Code Composer Studio and architecture of TMS 320C6416/6473 DSP Kit.

2. Implementation of FFT and its analysis Using TMS 320C6416 DSP Kit.
3. Design and analysis of FIR filter using TMS 320C6416 DSP Kit.
4. To implement LMS Algorithm using TMS 320C6416 DSP Kit.
5. To write a program for finding the heart rate variability using TMS 320C6416 DSP Kit.
6. To write a MATLAB program for computation of the PSD of two Sinusoids using Analog discovery 2 kit.
7. Implementation of BPSK Digital modulation using Analog discovery 2 kit.
8. Visualise the spectrum of vocal fold vibration using Electroglottograph using Analog discovery 2 kit.
9. Develop an algorithm for de-noising the biomedical signal and its implementation using TMS 320C6416 DSP kit.
10. Implementation of Noise cancellation in bio signal using TMS 320C6473 DSP Kit.
11. Implementation of Image segmentation using TMS 320C6473 DSP kit.
12. Implementation of Image compression using TMS 320C6473 DSP kit.

**Textbooks:**

1. Rulph Chassaing, “Digital Signal Processing and Applications with the C6713 and C6416 DSK”, Wiley, 2005
2. U. Meyer Baesse, “Digital Signal Processing with FPGAs”, Springer, 2001

**Reference Books:**

1. Behrooz Parhami, “Computer Arithmetic Algorithms and Hardware Design”, Oxford, 2000.
2. Shehrzad Qureshi, “Embedded Image Processing on the TMS320C6000™ DSP: Examples in Code Composer Studio™ and MATLAB.

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

NA

**POs met through Gaps in the Syllabus**

NA

**Topics beyond syllabus/Advanced topics/Design**

Simulations based on advanced topics after completion of compulsory twelve experiments.

**POs met through Topics beyond syllabus/Advanced topics/Design**

Assignments & Seminars

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool              | % Contribution during CO Assessment |
|------------------------------|-------------------------------------|
| Progressive Evaluation       | (60)                                |
| Attendance Marks             | 12                                  |
| Lab file Marks               | 12                                  |
| Viva Marks                   | 24                                  |
| Day-to-day performance Marks | 12                                  |
| End SEM Evaluation           | (40)                                |
| Lab quiz Marks               | 20                                  |
| Lab performance Marks        | 20                                  |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 3  | 2  | 3  |                                  |    |    |

|            |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |
|------------|---|---|---|---|---|---|---|---|---|---|---|---|--|--|--|
| <b>CO2</b> | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 3 |  |  |  |
| <b>CO3</b> | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |  |  |  |
| <b>CO4</b> | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |  |  |  |
| <b>CO5</b> | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |  |  |  |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Mapping between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD2, CD5, CD8                 |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1, CD2, CD5, CD8                 |
| CD3            | Seminars  | CO3                   | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD4, CD5, CD7, CD9                 |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

**COURSE INFORMATION SHEET**

**Course code:** EC313

**Course title:** Electronic Measurements

**Pre-requisite(s):** EC101 Basics of Electronics & Communication Engineering **Co-requisite(s):**

**Credits: L: 3 T: 0 P: 0 C: 3**

**Class schedule per week: 3**

**Class: B. Tech**

**Semester / Level: III/03 In-depth Specialization/Programme Elective**

**Branch: ECE**

**Name of Teacher:**

### **Course Objectives**

This course enables the students to:

|    |  |
|----|--|
| 1. | Understand the need and concept of measurement, calibration, standards, errors, static and dynamic performance characteristics of measuring instruments. |
| 2. | Demonstrate the operating principles of different analog and digital instruments.  |
| 3. | Experiment and analyze various a.c. and d.c. bridges for the measurement.  |
| 4. | Explain the operation and construction of analog and digital CRO used for different parameter measurement in the department laboratory.                  |
| 5. | Solve the problems of measuring non electrical parameters using different transducers.   |

### **Course Outcomes**

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Find and investigate errors and explain the static and dynamic characteristics of instruments.  |
| CO2 | Explain the working of different analog instruments (PMMC, Moving iron) and use them to design multi-range voltage, current and resistance measuring instruments. |
| CO3 | Demonstrate the process of balancing different bridge networks to find the value of unknown arm components.   |
| CO4 | Summarize the working of analog and digital CRO.  |
| CO5 | Schematize the measurement of non-electrical parameters using different transducers.  |

### **SYLLABUS**

| <b>MODULE</b> | <b>(NO. OF LECTURE HOURS)</b> |
|---------------|-------------------------------|
|               |                               |



|  |                  |
|--|------------------|
| <p><b>Module – I</b><br/>Introduction of measurements and measurement systems: Significance of measurements, different methods of measurements, Instruments used in measurements, Electronic Instruments and its classification, Elements of a Generalized Measurement System. Characteristics of instruments, Static characteristics, Errors in measurements, scale, range, and scale span, calibration, Reproducibility and drift, Noise, Accuracy and precision, Significant figures, Linearity, Hysteresis, Threshold, Dead time, Dead zone, Resolution and Loading Effects.</p> | <p><b>10</b></p> |
| <p><b>Module – II</b><br/><b>Analogue and Digital Instruments:</b> Classification and Principles of Operation, Working Details Moving Coil (PMMC) and Moving Iron Instruments Construction, DC Ammeter, DC Voltmeter, Series and Shunt type Ohmmeter. Analogue Electronic voltmeter, DC Voltmeter with chopper type DC amplifier, Advantages of digital over analogue processing. Digital Voltmeters Digital Multimeters, Digital frequency Meter.</p>   | <p><b>10</b></p> |
| <p><b>Module – III</b><br/>Introduction of DC and AC Bridges: Wheatstone Bridge, Kelvin Double Bridge, Maxwell’s Bridge, and Hay’s Bridge, Anderson’s Bridge, Scherings Bridge, Wien’s Bridge, Sources of errors in Bridges and their elimination by shielding and grounding. Q meter.</p>   | <p><b>7</b></p>  |
| <p><b>Module – IV</b><br/>Oscilloscopes: CRT, Construction, Basic CRO circuits, Block diagram of a modern oscilloscope, Y-amplifiers, X-amplifiers, Triggering, Oscilloscopic measurement. Special CRO's: Dual trace, Dual beam, Sampling oscilloscope, Storage CROs.</p>  | <p><b>5</b></p>  |

|   |                 |
|---|-----------------|
| <p><b>Module – V</b><br/> Transducers: Definition, Classification, Principle of Analogue transducer: Resistive (Strain Gauge, POT, Thermistor and RTD), Capacitive, Piezoelectric, Thermocouple and Inductive (LVDT) and RVDT) transducer, Working principle of Digital Transducer and Optical transducer. Application of above transducers to be discussed on the basis of Pressure, Displacement, Level, Flow and Temperature measurements.</p> | <p><b>8</b></p> |
|---|-----------------|

**Books recommended:**

**Textbooks:**

1. “Electrical and Electronic Measurements and Instrumentation” by A. K. Sawhney.
2. “Modern Electronic Instrumentation & Measurement Techniques” by Helfrick & Cooper.

**Reference books:**

1. “Electronic Instrumentation”, by H. S. Kalsi.

**Gaps in the syllabus (to meet Industry/Profession requirements): Visit to CIF, BIT Mesra.**

**POs met through Gaps in the Syllabus: N/A**

**Topics beyond syllabus/Advanced topics/Design: N/A**

**POs met through Topics beyond syllabus/Advanced topics/Design: N/A**

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher’s Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students’ Feedback on Course Outcome.

## Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |   |   |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|---|---|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1                                | 2 | 3 |
| CO1            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 |   |   | 3  |    | 3  | 3                                | 2 | 1 |
| CO2            | 3                      | 3 | 2 | 3 | 3 | 3 | 2 |   |   | 3  |    | 3  | 3                                | 2 | 1 |
| CO3            | 3                      | 3 | 2 | 3 | 3 | 3 | 2 |   |   | 3  |    | 3  | 3                                | 2 | 1 |
| CO4            | 3                      | 3 | 2 | 3 | 3 | 2 | 2 |   |   | 3  |    | 3  | 3                                | 2 | 1 |
| CO5            | 3                      | 3 | 2 | 3 | 3 | 2 | 2 |   |   | 3  |    | 3  | 3                                | 2 | 1 |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1,CD2,CD5,CD8             |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1,CD2,CD5,CD8             |
| CD3     | Seminars  | CO3            | CD1,CD2,CD5,CD8             |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1,CD2,CD5,CD8             |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD1,CD2,CD5,CD8             |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9     | Simulation  |                |                             |

## COURSE INFORMATION SHEET

**Course code: EC315**

**Course title: Introduction to Industrial Instrumentation**

**Pre-requisite(s): EC208 Electronic Measurements Lab Co-requisite(s):**

**Credits:** L: 3 T: 0 P: 0 C: 3

**Class schedule per week: 3x1**

**Class: B. Tech**

**Semester / Level: V/03**

**Branch: ECE Name**

**of Teacher:**

### Course Objectives

This course enables the students to:

|    |   |
|----|---|
| 1. | Understand the role of instrumentation for controlling different electrical or nonelectrical process variables in process industry. |
| 2. | Demonstrate the working of various components of an Automation System.  |
| 3. | Summarize the various control schemes used in industry.   |
| 4. | Experiment with PLC systems and its programming for controlling industrial processes.   |
| 5. | Schematize intelligent controllers for industrial applications.   |

### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Reproduce the different working principles of transducers and also design transducers for measurement of non-electrical process variables. |
| CO2 | Explain the role and working of different components of an industrial automation systems.  |
| CO3 | Investigate and analyse the various control schemes used in industry.  |
| CO4 | Demonstrate the working of PLC and its programming.  |
| CO5 | Apply the concept of intelligent controllers as dynamic controller to control the process with dynamic disturbances.                       |

## SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <p><b>Module – I</b><br/> <b>Review of Transducers:</b> Principles of operations and its classification, Characteristics, Technological trends in making transducers, Silicon sensors for the measurement of pressure, Level, Flow and Temperature, Bio-sensors ,types and its Application .Radiation Sensors, X -ray and Nuclear radiation sensors, Fiber optic sensors for Temperature, Liquid level, Fluid- flow measurement, Electro-analytical sensors: Electrochemical cell, Standard Hydrogen Electrode (SHE), Smart sensors.</p>   | <p><b>10</b></p>       |
| <p><b>Module – II</b><br/> <b>Components of Industrial Automation system:</b> Detailed study of each block involved in making of DAS, Signal Conditioners: as DA, IA, Signal Converters (ADC &amp; DAC), Sample and hold, Designing of Pressure, Temperature measuring instrumentation system using DAS, Data logger. Introduction about Automation system, Concepts of Control Schemes, Types of Controllers, Components involved in implementation of Automation system i.e., DAS, DOS, Converter ( I to P ) and Actuators: Pneumatic cylinder, Relay, Solenoid (Final Control Element).</p> | <p><b>10</b></p>       |
| <p><b>Module – III</b><br/> <b>Control Systems:</b> Concepts of Controllers Schemes, Types of Controllers, Computer Supervisory Control System (SCADA), Direct Digital Control's Structure and Software, Introduction to Distributed Digital Control.</p>  | <p><b>7</b></p>        |

|   |                 |
|---|-----------------|
| <p><b>Module – IV</b><br/> <b>Programmable Logic Controllers:</b> Introduction of Programmable logic controller, Principles of operation, Architecture of Programmable controllers, Programming the Programmable controller.</p>  | <p><b>8</b></p> |
| <p><b>Module – V</b><br/> <b>Intelligent Controllers:</b> Introduction to Intelligent Controllers, Model based controllers, Predictive control, Artificial Intelligent Based Systems, Experts Controller, Fuzzy Logic System and Controller, Artificial Neural Networks, Neuro-Fuzzy Controller system.</p> | <p><b>5</b></p> |

**Books recommended:**

**Textbooks:**

1. “Computer-Based Industrial Control”, by Krishna Kant, PHI.
2. “Process Control Instrumentation Technology”, by Curtis D Johnson, Pearson Ed.

**Reference books:**

1. “Sensors and Transducers”, 2/E by D. Patranabis

**Gaps in the syllabus (to meet Industry/Profession requirements):**

**POs met through Gaps in the Syllabus:** N/A

**Topics beyond syllabus/Advanced topics/Design:** N/A

**POs met through Topics beyond syllabus/Advanced topics/Design:** N/A

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |

|                          |    |
|--------------------------|----|
| Teacher's Assessment     | 5  |
| End Semester Examination | 50 |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 1  |
| CO2            | 3                      | 3 | 2 | 3 | 3 | 3 | 2 |   |   | 3  |    | 3  | 3                                | 3  | 1  |
| CO3            | 3                      | 3 | 2 | 3 | 3 | 3 | 2 |   |   | 3  |    | 3  | 3                                | 3  | 1  |
| CO4            | 3                      | 3 | 2 | 3 | 3 | 2 | 2 |   |   | 3  |    | 3  | 3                                | 3  | 1  |
| CO5            | 3                      | 3 | 2 | 3 | 3 | 2 | 2 |   |   | 3  |    | 3  | 3                                | 3  | 1  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD2, CD7, CD 8         |
| CD2     | Tutorials/Assignments                   | CO2            | CD1, CD2, CD7, CD 8         |
| CD3     | Seminars                                | CO3            | CD1, CD2, CD7, CD 8         |

|     |   |     |                     |
|-----|---|-----|---------------------|
| CD4 | Mini Projects/Projects                                      | CO4 | CD1, CD2, CD7, CD 8 |
| CD5 | Laboratory Experiments/Teaching Aids                        | CO5 | CD1, CD2, CD7, CD 8 |
| CD6 | Industrial/Guest Lectures                                   |     |                     |
| CD7 | Industrial Visits/In-plant Training                         |     |                     |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |     |                     |
| CD9 | Simulation  |     |                     |

### COURSE INFORMATION SHEET

Course code: **EC316**

Course title: **Industrial Instrumentation Lab**

Pre-requisite(s): Electronic Measurement, Sensor and transducers,

Co- requisite(s): Electronic measurement Lab

Credits: L: 0 T: 0 P: 3

Class schedule per week: 03 Class:

B. Tech.

Semester / Level: 03

Branch: ECE Name

of Teacher:

#### Course Objectives

This course enables the students to:

|    |   |
|----|---|
| 1. | To provide exposure to various measuring techniques for flow, level, vibration etc. |
| 2. | To demonstrate the working of different actuators.                                  |
| 3. | To introduce virtual instrumentation with Lab VIEW software.                        |
| 4. | To program PLC for different real time control application.                         |
| 5. | To demonstrate various controllers parameter tuning.                                |

#### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Demonstrate the measuring techniques for flow, level, vibration etc. |
|-----|--|



|     |  |
|-----|--|
| CO2 | Actuate control signal using different actuators for controlling valves. |
| CO3 | Able to design measuring instruments using Lab VIEW software.            |
| CO4 | Program PLC for given real time application.                             |
| CO5 | Schematize various control loop for industrial application.              |

## SYLLABUS

### List of experiments:

1. **Name of the Experiment**  
**FLOW MEASUREMENT**  
**Aim1.** Flow Measurement using orifice, U tube Manometer and Rotameter.
2. **Name of the Experiment**  
**FLOW CONTROL LOOP**  
**Aim1.** Liquid flow control using Flow control loop trainer.
3. **Name of the Experiment**  
**VIBRATION MEASUREMENT**  
**Aim1.** Displacement Velocity and Acceleration measurement using Piezoelectric acceleration sensor.
4. **Name of the Experiment**  
**PNEUMATIC TRAINER**  
**Aim1.** Perform actuations using Pneumatic Actuator Trainer.
5. **Name of the Experiment**  
**PRESSURE CONTROL LOOP**  
**Aim1.** Pneumatic Pressure control using Pressure control loop trainer.
6. **Name of the Experiment**  
**LEVEL CONTROL LOOP**  
**Aim1.** Liquid Level control using Level control loop trainer
7. **Name of the Experiment I to P CONVERTOR**  
**Aim1.** Study of current to pressure converter.
8. **Name of the Experiment PLC-I**  
**Aim1.** Lift control using ABB PLC
9. **Name of the Experiment PLC-II**  
**Aim1.** Logic gate simulation on ABB PLC.
10. **Name of the Experiment**  
**PRESSURE GAUGE TESTER**

**Aim1.** Calibration of pressure instruments using dead weight pressure gauge tester.

**11. Name of the Experiment Lab VIEW-I**

**Aim1.** Design of function generator using Lab VIEW.

**12. Name of the Experiment Lab VIEW-II**

**Aim1.** Design of CRO using Lab VIEW

**Books recommended:**

**Textbooks:**

3. "Computer-Based Industrial Control", by Krishna Kant, PHI.
4. "Process Control Instrumentation Technology", by Curtis D Johnson, Pearson Ed.

**Reference books:**

2. "Sensors and Transducers", 2/E by D. Patranabis

**Gaps in the syllabus (to meet Industry/Profession requirements):** Visit CIF lab at BIT Mesra.

POs met through Gaps in the Syllabus: N/A.

**Topics beyond syllabus/Advanced topics/Design:** N/A

**POs met through Topics beyond syllabus/Advanced topics/Design:** N/A

**Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure**

**Direct Assessment**

| <b>Assessment Tools</b>        | <b>% Contribution during CO Assessment</b> |
|--------------------------------|--|
| Continuous Internal Assessment | 60   |
| Semester End Examination       | 40   |

| <b>Continuous Internal Assessment</b> | <b>% Distribution</b> |
|---------------------------------------|-----------------------|
| Day to day performance & Lab files    | 30                    |
| Quiz(zes)                             | 10                    |
| Viva                                  | 20                    |

| <b>Semester End Examination</b> | <b>% Distribution</b> |
|---------------------------------|-----------------------|
|---------------------------------|-----------------------|

|                                    |    |
|------------------------------------|----|
| Examination Experiment Performance | 30 |
| Quiz                               | 10 |

**Indirect Assessment**

1. Student Feedback on Course

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |   |   |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|---|---|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1                                | 2 | 3 |
| CO1            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 1  |    | 1  | 2                                | 2 | 1 |
| CO2            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 |   | 1 | 1  |    | 1  | 2                                | 2 | 1 |
| CO3            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 |   | 1 | 1  |    | 1  | 2                                | 2 | 1 |
| CO4            | 3                      | 3 | 3 | 2 | 2 | 1 | 1 |   | 1 | 1  |    |    | 2                                | 2 | 1 |
| CO5            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 1  |    | 1  | 2                                | 2 | 1 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD5                         |
| CD2     | Tutorials/Assignments                   | CO2            | CD5                         |
| CD3     | Seminars                                | CO3            | CD5, CD9                    |

|     |   |     |          |
|-----|---|-----|----------|
| CD4 | Mini Projects/Projects                                      | CO4 | CD5, CD9 |
| CD5 | Laboratory Experiments/Teaching Aids                        | CO5 | CD5, CD8 |
| CD6 | Industrial/Guest Lectures                                   |     |          |
| CD7 | Industrial Visits/In-plant Training                         |     |          |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |     |          |
| CD9 | Simulation  |     |          |

### COURSE INFORMATION SHEET

**Course code: EC319**

**Course title: VLSI Systems**

**Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering, EC201 Electronic Devices Co- requisite(s):**

**Credits:** L: 3 T: 0 P: 0 C: 3

**Class schedule per week: 03 Class:**

B. Tech.

**Semester / Level: V/03**

**Branch: ECE Name**

**of Teacher:**

#### Course Objectives

This course enables the students to:

|    |   |
|----|---|
| 1. | Understand the static and dynamic behavior of MOSFET and CMOS inverter.   |
| 2. | Interpret the interconnect routing issues, interconnection problems and solutions in integrated circuits and apply the perceived knowledge. |
| 3. | Appraise and analyse the characteristics of combinational logic gates in CMOS.  |
| 4. | Design and Evaluate the characteristics of sequential logic circuits.   |
| 5. | Create the NMOS/CMOS gain stages for desired gains and analyze their frequency responses.   |

#### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Describe and illustrate the static and dynamic behavior of MOSFET and CMOS inverter.   |
| CO2 | Sketch interconnect parasitics. Explain the interconnect routing issues, interconnection problems and solutions in Integrated Circuit. |
| CO3 | Diagram and explain the combinational logic circuits and illustrate their characteristics and analyse them.                            |
| CO4 | Schematize the sequential logic circuits, assess their characteristics and summarize their features.                                   |
| CO5 | Design the NMOS/CMOS gain stages for desired gains, schematize their frequency responses and analyze them.                             |

## SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b><br/> <b>Static and dynamic behavior of MOSFET and CMOS inverter:</b><br/> <b>The MOS(FET) Transistor:</b> Static Conditions, Dynamic Behavior, Secondary Effects. Static and Dynamic Behaviour of CMOS Inverter: Switching Threshold, Noise Margin formulation, Computing the Capacitances, Propagation Delay, Power, Delay, Power-Delay Product, Energy-Delay Product.</p>                      | <b>8</b>               |
| <p><b>Module – II</b><br/> The Wire and Interconnection:<br/> Interconnect Parameters, Electrical Wire Models, Capacitive Parasitics, Resistive Parasitics, Inductive Parasitics, Advanced Interconnect Techniques, <b>I/O structures Design:</b> VDD and VSS pads, output &amp; input pads, tri-state and bidirectional pads, application of Schmitt trigger in I/O pads, MOSIS I/O pads, Mixed-Voltage I/O pad.</p> | <b>8</b>               |

|   |                 |
|---|-----------------|
| <p><b>Module – III</b><br/> <b>Designing Combinational Logic Gates in CMOS:</b><br/> <b>Static CMOS Design:</b> Complementary CMOS, Ratioed Logic, Pass-Transistor Logic (PTL), Complementary pass-transistor logic (CPL), <b>Dynamic CMOS Design and issues, Domino logic and issues, np-CMOS,</b> Introduction to the SPICE, Verilog, SystemVerilog with Design examples of inverter, NAND and NOR gates.</p>                                     | <p><b>8</b></p> |
| <p><b>Module – IV</b><br/> <b>Designing Sequential Logic Circuits:</b><br/> Latches and Registers, Dynamic Latches and Registers, Alternative Register Styles: Pulse Registers, Sense-Amplifier Based Registers; Pipelining: Latch-versus Register-Based Pipelines, NORA-CMOS—A Logic Style for Pipelined Structures; Nonbistable Sequential Circuits, Design examples of latch, flip-flop and register using Verilog, SystemVerilog HDL.</p>       | <p><b>8</b></p> |
| <p><b>Module – V</b><br/> <b>Basic NMOS/CMOS gain stages and their frequency responses:</b><br/> MOS Amplifier Topologies, Biasing, Realization of Current Sources, CS Core, CS stage With Resistive Load, Current-Source Load, and Diode-Connected Load, CS Stage with Source Degeneration, CG Stage with Biasing, Source Follower with Biasing, Cascode Stage as a Current Source, Cascode Stage as an Amplifier; general frequency response.</p> | <p><b>8</b></p> |

**Textbooks:**

1. Jan M. Rabaey, A. Chandrakasan, B. Nikolic, “Digital Integrated Circuits: A Design Perspective”, 2nd ed., Prentice Hall, 2003.
2. Neil H. E. Weste, David Money Harris, “CMOS VLSI Design – A Circuits and Systems Perspective,” 4<sup>th</sup> ed., Addison Wesley, 2011.
3. Neil H. E. Weste, David Money Harris, “CMOS VLSI Design – A Circuits and Systems Perspective,” 3<sup>rd</sup> ed., Pearson Education, 2006.

**Reference books:**

2. Behzad Razavi, “Fundamentals of Microelectronics,” Wiley, 2009.
3. Samir Palnitkar, “Verilog HDL: A guide to Digital Design and Synthesis,” SunSoft Press, 1996.
4. Stuart Sutherland, Simon Davidmann, Peter Flake, “SystemVerilog Design - A Guide to Using SystemVerilog for Hardware Design and Modeling,” 2<sup>nd</sup> ed., Springer, 2006.

**Gaps in the syllabus (to meet Industry/Profession requirements):**

1. Hands-on-practical for CMOS IC (Integrated Circuit) fabrication.

**POs met through Gaps in the Syllabus:**

10

**Topics beyond syllabus/Advanced topics/Design:**

1. Memory and RF circuits.

**POs met through Topics beyond syllabus/Advanced topics/Design:**

1. N/A

**Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure**

**Direct Assessment**

| <b>Assessment Tool</b>   | <b>% Contribution during CO Assessment</b> |
|--------------------------|--|
| First Quiz               | 10   |
| Mid Semester Examination | 25   |
| Second Quiz              | 10   |
| Teacher's Assessment     | 5  |
| End Semester Examination | 50   |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| <b>Course Outcome</b> | <b>Program Outcomes (POs)</b> |          |          |          |          |          |          |          |          |           |           |           | <b>Program Specific Outcomes (PSOs)</b> |           |           |
|-----------------------|-------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|---|-----------|-----------|
|                       | <b>1</b>                      | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>6</b> | <b>7</b> | <b>8</b> | <b>9</b> | <b>10</b> | <b>11</b> | <b>12</b> | <b>13</b>                               | <b>14</b> | <b>15</b> |

|            |   |   |   |   |   |   |   |  |  |   |  |   |   |   |   |
|------------|---|---|---|---|---|---|---|--|--|---|--|---|---|---|---|
| <b>CO1</b> | 3 | 3 | 2 | 3 | 3 | 1 | 1 |  |  | 3 |  | 3 | 3 | 2 | 1 |
| <b>CO2</b> | 3 | 3 | 2 | 3 | 3 | 3 | 2 |  |  | 3 |  | 3 | 3 | 2 | 1 |
| <b>CO3</b> | 3 | 3 | 2 | 3 | 3 | 3 | 2 |  |  | 3 |  | 3 | 3 | 2 | 1 |
| <b>CO4</b> | 3 | 3 | 2 | 3 | 3 | 2 | 2 |  |  | 3 |  | 3 | 3 | 2 | 1 |
| <b>CO5</b> | 3 | 3 | 2 | 3 | 3 | 2 | 2 |  |  | 3 |  | 3 | 3 | 2 | 1 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD7, CD 8                     |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1 and CD9                        |
| CD3            | Seminars  | CO3                   | CD1, CD2 and CD3                   |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1 and CD2                        |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1 and CD2                        |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

**COURSE INFORMATION SHEET**

**Course code: EC320**

**Course title: VLSI Systems Lab**

**Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering, EC201 Electronic Devices**

**Co- requisite(s): EC319 VLSI Systems**

**Credits:        L: 0    T: 0    P: 3    C: 1.5**

**Class period per week: 03 Class:**

B. Tech.

**Semester / Level: V/03**

**Branch: ECE Name**

**of Teacher:**

**Course Objectives**

This course enables the students to:

|    |   |
|----|---|
| 1. | Understand the structural, behavioural, data-flow models for digital circuits simulation. |
|----|---|



|    |   |
|----|---|
| 2. | Apply their understanding to design digital circuits/universal gates and draw layout of the same. |
| 3. | Analyse the MOS device characteristics and its model parameters.                                  |
| 4. | Integrate basic blocks to build a bigger module and evaluate the results.                         |
| 5. | Create/develop digital and analog subsystems keeping design goals in consideration.               |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Translate/express their theoretical knowledge while modelling/designing the basic digital circuits using HDL and Xilinx ISE and observe and explain the simulation results.   |
| CO2 | Write HDL RTL codes for designing digital circuits, simulate HDL RTL codes, and observe/examine the results. Interpret the same for the correctness of their functionality. Sketch layouts of universal gates. Simulate and observe/examine the results. Interpret the same for the correctness of their functionality. Apply appropriate bias to the terminals of an nMOSFET/pMOSFET. Simulate and show the output and transfer curves. Determine various MOSFET parameters. |
| CO3 | Outline a VHDL/Verilog model and write RTL codes for Moore/Mealy machines and digital circuits. Test for their operation and analyse the results.   |
| CO4 | Evaluate a properly biased short-channel nMOSFET and test it for the short-channel effects.   |
| CO5 | Design 2-input NAND gate using SCMOS and pseudo-nMOS logic families and design a 2-input XOR using symbols of 2-input SCMOS NAND gate to achieve design goal. Simulate the designs, test and validate the results. Design/develop single-stage and two-stage CMOS amplifiers. Simulate the design, test and validate the anticipated gain / frequency response.   |

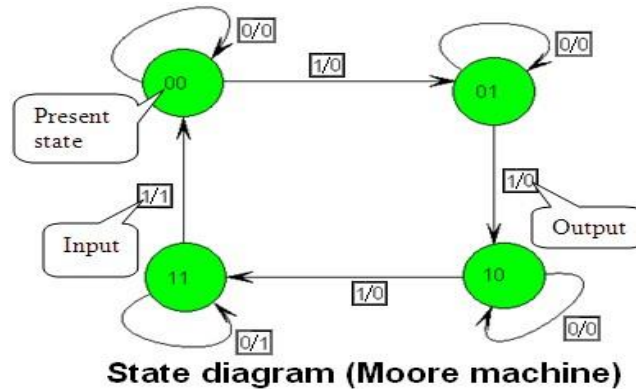
### SYLLABUS

Lab is the application of the theory (i.e., hands-on experiments related to the course contents). Therefore, **EC319 VLSI Systems** is the syllabus for the **EC320 VLSI System Lab**. Following experiments are the guidelines for the students. However, the questions for exams are not limited to this experiment list.

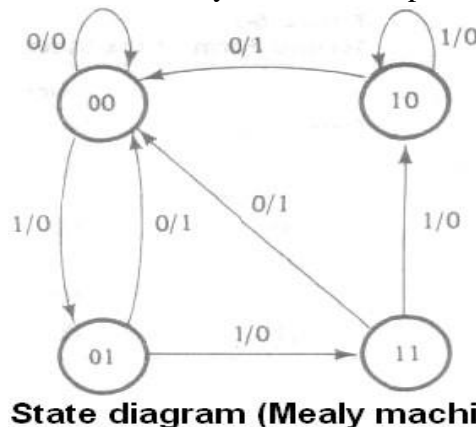
#### List of compulsory experiments:

1. Outline a model of seven-segment decoder to display HEX digits and translate the same into VHDL/Verilog/SystemVerilog RTL code. Simulate the design and find errors, if any. Observe and show the results.
2. Sketch/draw layouts of 2-input CMOS NAND gate and 2-input CMOS NOR gate by the direct translation of their schematics. Perform DRC (design rule checking) on the dawn layout and find design rule errors, if any. Simulate and observe/examine the results. Interpret the same for the correctness of their functionality.

- Outline a VHDL/Verilog model and write RTL code for a Moore machine with the following state transition diagram. Simulate/compile the same using the Xilinx development software (**Xilinx ISE 8.1i./10.1i**) and find errors, if any. Test for its operation and analyse the results.



- Outline a VHDL/Verilog model and write RTL code for a Mealy machine with the following state transition diagram. Simulate/compile the same using the Xilinx development software (**Xilinx ISE 8.1i./10.1i**) and find errors, if any. Test for its operation and analyse the results.



- Write a VHDL/Verilog/SystemVerilog RTL code to develop a tri-stated buffer controlled 4channel multiplexer with each channel carrying 4 signals. Simulate/compile the same using the Xilinx development software (**Xilinx ISE 8.1i./10.1i**) and find errors, if any. Test and evaluate the obtained results.
- Write VHDL/Verilog/SystemVerilog RTL code and develop/design an adder that adds three 8-bit binary number. Simulate using the Xilinx development software (**Xilinx ISE 8.1i./10.1i**) and find errors, if any, test and validate its operation.
- Apply appropriate bias voltages to the terminals of an nMOSFET/pMOSFET. Change the bias voltage & simulate using Virtuoso Analog Design Environment of Cadence and show the  $I_D V_D$  and  $I_D - V_G$  curves. Determine MOSFET parameters:  $r_{on}$ ,  $\mu_n$ ,  $\mu_p$ ,  $g_m$ ,  $g_{ds}$ ,  $C_{gb}$ ,  $C_{gs}$ ,  $C_{gd}$ ,  $V_{tn}$ , and  $V_{tp}$ .
- Evaluate a properly biased short-channel nMOSFET and test it for the short-channel effects: channel length modulation (CLM), drain-induced barrier lowering (DIBL),  $V_t$  rolloff using Virtuoso ADE of Cadence.
- Design 2-input NAND gate using SCMOS and pseudo-nMOS logic families with given specifications with the Virtuoso ADE of Cadence and design a 2-input XOR using symbols of 2-input SCMOS NAND gate to achieve propagation delay ( $t_p$ ) not longer than 20 ns and

average power consumption ( $P_{avg}$ ) not higher than  $10 \mu W$ . Simulate the designs, test and validate your anticipation. Simulate and report the propagation delay ( $t_p$ ) and power consumption ( $P_{avg}$ ) of your XOR gate. Load the input and output of XOR gate with singlestage NAND to make the input and output realistic.

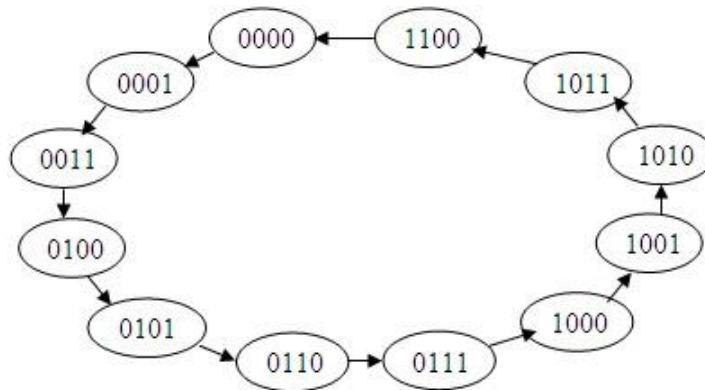
10. Design a common source (CS) amplifier using an nMOSFET ( $Q_1$ ) with a small-signal gain of at least 3 with respect to ground with the Virtuoso ADE of Cadence. Implement the load current with current source  $I_{DC}$  and pMOSFET current mirror, input device of which is  $Q_3$  and output device of which is  $Q_2$ . Simulate the design, test and validate the anticipated gain.
11. Design an inverting differential amplifier with a gain of at least 3 with respect to ground using the Virtuoso ADE of Cadence. Simulate the design, test and validate the anticipated gain.
12. Design an Op Amp based square wave generator with a frequency of at least 1 MHz using the Virtuoso ADE of Cadence. Simulate the design, test and validate the anticipated frequency response.

### List of optional experiments:

13. Write a VHDL/Verilog/SystemVerilog model and prepare a Linear-Feedback Shift Register (LFSR). Use the same to develop a Pseudo Random Sequence Generator (PRSG). Simulate and examine the results. Interpret the same for the correctness of its functionality. CO2
14. Write a VHDL/Verilog/SystemVerilog model and develop a Fibonacci LFSR with characteristic polynomial of  $1 + x + x^4$ . Simulate it with the seed test pattern = 1000 and prepare a table with the results. Interpret the same for its correctness. CO2
15. Write a VHDL/Verilog/SystemVerilog model and develop an 8-bit barrel shifter. Simulate it with the seed test pattern = 11000110 and prepare a table and record the results for consecutive 8 clock pulses. Examine the same for its correctness. CO2
16. Draw the layout of an inverter with donut (round transistor) connection on Microwind 2.6a. Show the advantage of donut connection compared to the layout that is drawn by the direct translation of its schematic.
17. Draw the layout of 2-input NAND gate that has less drain area connected to the output node and show how this layout improves gate performance compared to the layout that is drawn by the direct translation of its schematic.
18. Draw the optimized layout of a 4-input domino AND gate to improve its performance and show how this layout improves gate performance compared to the layout that is drawn by the direct translation of its schematic.
19. Draw the layout of 2-input NOR gate that has less drain area connected to the output and show how this layout improves gate performance compared to the layout that is drawn by the direct translation of its schematic.
20. Write a VHDL/Verilog/SystemVerilog model and develop a 4:1-bit multiplexer. Simulate and synthesize the CPLD design using the Xilinx development software (Xilinx ISE 8.1i.) and find errors, if any. Create the CPLD configuration bitstream file (\*.jed), use Spartan-2 CPLD Trainer Kit and download CPLD design (using the iMPACT programming software and the JTAG cable) onto it, demonstrate and interpret the results displayed on the kit.CO2
21. Develop a VHDL/Verilog/SystemVerilog model and design a parameterized N-bit parity generator circuit. The model should provide both an odd parity and an even parity output. Simulate and compile/synthesize the FPGA design using the Xilinx development software, create the FPGA configuration bitstream file (\*.bit), download FPGA design (using the

iMPACT programming software and the USB cable) onto the prototyping kit (use Spartan-3E FPGA Starter Kit), test and validate its operation. CO5

22. Write a VHDL/Verilog model and develop a 4×16 decoder. Simulate the design using the Xilinx development software (Xilinx ISE 8.1i/10.1i) and find errors, if any. Observe/examine the results. Interpret the same for the correctness of their functionality.
23. Outline a model of 4-bit ripple carry full adder and translate/express the same into VHDL/Verilog RTL code. Simulate/compile the same using the Xilinx development software (Xilinx ISE 8.1i./10.1i) and find errors, if any. Observe and show the results and explain the same.
24. Outline a VHDL/Verilog model and write RTL code for a synchronous counter` with the following states. Simulate/compile the same using the Xilinx Integrated Synthesis Environment (ISE) 8.1i./10.1i) and find errors, if any. Test for its operation and analyse the results.



#### **Textbooks:**

4. Jan M. Rabaey, A. Chandrakasan, B. Nikolic, “Digital Integrated Circuits: A Design Perspective”, 2nd ed., Prentice Hall, 2003.
5. Neil H. E. Weste, David Money Harris, “CMOS VLSI Design – A Circuits and Systems Perspective,” 4<sup>th</sup> ed., Addison Wesley, 2011.
6. Neil H. E. Weste, David Money Harris, “CMOS VLSI Design – A Circuits and Systems Perspective,” 3<sup>rd</sup> ed., Pearson Education, 2006.

#### **Reference books:**

5. Behzad Razavi, “Fundamentals of Microelectronics,” Wiley, 2009.
6. Samir Palnitkar, “Verilog HDL: A guide to Digital Design and Synthesis,” SunSoft Press, 1996.
7. Stuart Sutherland, Simon Davidmann, Peter Flake, “SystemVerilog Design - A Guide to Using SystemVerilog for Hardware Design and Modeling,” 2<sup>nd</sup> ed., Springer, 2006.

#### **Gaps in the syllabus (to meet Industry/Profession requirements):**

1. Hands-on-practical for CMOS IC (Integrated Circuit) fabrication.

**POs met through Gaps in the Syllabus:**

10.

**Topics beyond syllabus/Advanced topics/Design:**

1. Memory and RF circuits.

**POs met through Topics beyond syllabus/Advanced topics/Design:**

10

**Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure****Direct Assessment**

| Assessment Tools               | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | 60                                  |
| Semester End Examination       | 40                                  |

| Continuous Internal Assessment     | % Distribution |
|------------------------------------|----------------|
| Day to day performance & Lab files | 30             |
| Quiz(zes)                          | 10             |
| Viva                               | 20             |

| Semester End Examination           | % Distribution |
|------------------------------------|----------------|
| Examination Experiment Performance | 30             |
| Quiz                               | 10             |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 3                                | 3  | 2  |
| CO2            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 3                                | 3  | 2  |
| CO3            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 3                                | 3  | 2  |

|            |   |   |   |   |   |   |   |   |  |   |  |   |   |   |   |
|------------|---|---|---|---|---|---|---|---|--|---|--|---|---|---|---|
| <b>CO4</b> | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |  | 3 |  | 3 | 3 | 3 | 1 |
| <b>CO5</b> | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 |  | 3 |  | 3 | 3 | 3 | 1 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Course Delivery Methods**

|     |   |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors      |
| CD2 | Assignments   |
| CD3 | Laboratory experiments/Teaching aids/Seminars               |
| CD4 | Mini Projects   |
| CD5 | Industrial visits/in-plant training                         |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation  |

**Mapping between Course Outcomes and Course Delivery Method**

| <b>Course Outcomes</b> | <b>Course Delivery Method</b> |
|------------------------|-------------------------------|
| CO1                    | CD1, CD3, CD6, CD7            |
| CO2                    | CD1, CD3, CD6, CD7            |
| CO3                    | CD1, CD3, CD6, CD7            |
| CO4                    | CD1, CD3, CD6, CD7            |
| CO5                    | CD1, CD3, CD6, CD7            |

**COURSE INFORMATION SHEET**

**Course code:** EC321

**Course title:** Microelectronic Devices and Circuits

**Pre-requisite(s):** EC101 Basics of Electronics & Communication Engineering, EC201

**Electronic Devices Co- requisite(s):**

**Credits:** L: 3 T: 0 P: 0 C: 3

**Class schedule per week:** 03 **Class:** B.

Tech.

**Semester / Level:** V/03

**Branch:** ECE **Name**

**of Teacher:**

## Course Objectives

This course enables the students to:

|     |  |
|-----|--|
| 6.  | Understand the Physics of Modern Devices.  |
| 7.  | Grasp the characteristics modern MOS Devices and apply the obtained knowledge.                           |
| 8.  | Appraise and analyse the CMOS Performance Factors.   |
| 9.  | Evaluate the characteristics of Current Mirrors, Single- and -two Stage OTA.                             |
| 10. | Comprehend the manufacturing principles of CMOS integrated circuits and create/develop their structures. |

## Course Outcomes

After the completion of this course, a student will be able to:

|     |  |
|-----|--|
| CO1 | Describe and illustrate the Physics of Modern Devices.   |
| CO2 | Sketch and explain the modern MOS Devices.   |
| CO3 | Illustrate with the sketch the CMOS Performance Factors, diagram their characteristics and analyse them.                         |
| CO4 | Design and schematize the Current Mirror, Single- and -two Stage OTA; assess their characteristics and summarize their features. |
| CO5 | Appraise the Manufacturing steps and Layout of CMOS Integrated Circuits and create/develop/design their structures.              |

## SYLLABUS

| MODULE | (NO. OF LECTURE HOURS) |
|--------|------------------------|
|        |                        |

|   |                 |
|---|-----------------|
| <p><b>Module – I</b><br/> <b>Basic Device Physics:</b><br/> Modern CMOS Transistors: CMOS processes, CMOS process enhancements, <b>Metal-Silicon Contacts, High-Field Effects:</b> Impact Ionization and Avalanche Breakdown, Band-to-Band Tunneling, Tunneling into and through Silicon Dioxide, Injection of Hot Carriers from Silicon into Silicon Dioxide, High-Field Effects in Gated Diodes, Dielectric Breakdown</p>   | <p><b>8</b></p> |
| <p><b>Module – II</b><br/> <b>MOS Devices:</b><br/> Long-Channel MOSFETs, Short-Channel MOSFETs, MOSFET Scaling, Threshold Voltage: Various Definitions of Threshold Voltage, Channel Profile Design, Nonuniform Doping, Quantum Effect on Threshold Voltage, Discrete Dopant Effects on Threshold Voltage. MOSFET Channel Length: Various Definitions of Channel Length, Extraction of the Effective Channel Length.</p>   | <p><b>8</b></p> |
| <p><b>Module – III</b><br/> <b>CMOS Performance Factors:</b><br/> Basic CMOS Circuit Elements, Parasitic Elements, Sensitivity of CMOS Delay to Device Parameters, Performance Factors of Advanced CMOS Devices: MOSFETs in RF Circuits, Effect of Transport Parameters on CMOS Performance, Low-Temperature CMOS.</p>  | <p><b>8</b></p> |
| <p><b>Module – IV</b><br/> <b>Current Mirrors, Single- and -two Stage OTA:</b><br/> Current Mirror, MOS Differential Pair: Qualitative Analysis, Large-Signal Analysis, Small-Signal Analysis; Frequency Response of Differential Pairs; Design of Current-sink CMOS inverting Amplifier, General Characteristics of the ideal CMOS OTA, Division of a two-stage uncompensated CMOS OTA into voltage-to-current and current-to-voltage stages, Functions of different stages, two-stage CMOS OTA.</p> | <p><b>8</b></p> |



|  |                 |
|--|-----------------|
| <p><b>Module – V</b><br/> <b>Manufacturing steps and Layout of CMOS Integrated Circuits:</b><br/> <b>CMOS IC fabrication Steps:</b> Silicon Wafer, Diffusion, ion-implantation, annealing, etching, patterning or lithography, oxidation, sputtering, deposition, metallization, planarization; <b>Layout:</b> Design Rules, Stick Diagram, Layouts of Universal Gates &amp; complex logic gates; Variability and Mismatch; <b>Analog Layout Considerations:</b> Analog design issues, common-centroid layout, capacitor &amp; resistor layout and matching.</p> | <p><b>8</b></p> |
|--|-----------------|

**Textbooks:**

1. Neil H. E. Weste and Kamran Eshraghian, “Principles of CMOS VLSI Design: A Systems Perspective”, 2<sup>nd</sup> ed., Addison-Wesley, 1993.
2. Y. Taur and T. H. Ning, “Fundamentals of Modern VLSI Devices,” Cambridge University Press, NY, USA, 2/e, 2009.
3. Behzad Razavi, Fundamentals of Microelectronics, Wiley, 2009.
4. Neil H. E. Weste and David Harris, “CMOS VLSI Design: A Circuits and Systems Perspective”, 4<sup>th</sup> International Edition, Pearson Education, Inc., 2011.

**Reference books:**

1. Tony Chan Carusone, David A. Johns and Kenneth W. Martin, Analogue Integrated Circuit Design, 2/e, John Wiley & Sons, 2012.
2. Phillip E. Allen & Douglas R. Holberg, CMOS Analog Circuit Design, 3/e, Oxford University Press, 2012.

**Gaps in the syllabus (to meet Industry/Profession requirements):**

1. Hands-on-practical for Device/IC fabrication.

**POs met through Gaps in the Syllabus:**

10

**Topics beyond syllabus/Advanced topics/Design:**

1. CNFET
2. TFET
3. MTJ
4. Memristor
5. SET 6. RTD.

**POs met through Topics beyond syllabus/Advanced topics/Design: 10**

**Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure**

## Direct Assessment

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

## Indirect Assessment

1. Students' Feedback on Course Outcome.

## Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO2            | 3                      | 3 | 2 | 3 | 3 | 2 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO3            | 3                      | 3 | 2 | 3 | 3 | 2 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO4            | 3                      | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO5            | 3                      | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |

## Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

## Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD7, CD 8              |
| CD2     | Tutorials/Assignments                   | CO2            | CD1 and CD9                 |
| CD3     | Seminars                                | CO3            | CD1, CD2 and CD3            |
| CD4     | Mini Projects/Projects                  | CO4            | CD1 and CD2                 |

|     |   |     |             |
|-----|---|-----|-------------|
| CD5 | Laboratory Experiments/Teaching Aids                        | CO5 | CD1 and CD2 |
| CD6 | Industrial/Guest Lectures                                   |     |             |
| CD7 | Industrial Visits/In-plant Training                         |     |             |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |     |             |
| CD9 | Simulation  |     |             |

## COURSE INFORMATION SHEET

**Course code: EC323**

**Course title: Microwave Theory and Techniques Pre-**

**requisite(s): EC257 Electromagnetic Fields and Waves Co-**

**requisite(s): EC324 Microwave Engineering Lab.**

**Credits: L: 3 T: 0 P: 0 C: 3**

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: V/03**

**Branch: ECE**

**Name of Teacher:**

### Course Objectives

This course enables the students to:

|     |  |
|-----|--|
| 6.  | To appraise the requirements of Microwave engineering                                      |
| 7.  | To develop ability to analyse microwave networks.  |
| 8.  | To describe and analyse the operation of Microwave sources and amplifiers.                 |
| 9.  | To differentiate, describe, design and analyse the active and passive microwave components |
| 10. | To differentiate, describe, design and analyse reciprocal and nonreciprocal components     |

### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | To describe the characteristics and applications of microwave engineering                  |
| CO2 | To define microwave network theories and analyse the various microwave networks.           |
| CO3 | To design, characterize and describe microwave sources and amplifiers.                     |
| CO4 | To differentiate, describe, design and analyse the active and passive microwave components |
| CO5 | To differentiate, describe, design and analyse reciprocal and nonreciprocal components     |

## SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <b>Module – I</b><br><b>Introduction to Microwave and Microwave Network Analysis:</b> Microwave Frequency bands, Applications of Microwaves, Equivalent Voltages and currents, Impedance and Admittance Matrices, Scattering Parameters, The Transmission (ABCD) Matrix. | <b>8</b>               |
| <b>Module – II</b><br>Passive Microwave Devices and Components: Basic Properties of Dividers and Couplers, The T-Junction Power Divider, Wilkinson Power Divider, Waveguide Directional Couplers, Quadrature (90°) Hybrid, Coupled Line Directional Couplers.            | <b>8</b>               |
| <b>Module – III</b><br><b>Microwave Tubes:</b> Limitations and Losses of conventional Tubes at Microwave Frequencies, Klystron, Travelling Wave Tube, Magnetron  | <b>8</b>               |
| <b>Module – IV</b><br>Microwave Filters: Filter Types and parameters, Realization of Butterworth and Chebyshev type filter, Filter Implementation.   | <b>8</b>               |
| <b>Module – V</b><br><b>Design of Ferromagnetic Components:</b> Intro to Ferromagnetic Material, Faraday rotation in ferrite, Ferrite Isolators, Ferrite Phase Shifters, Ferrite Circulators.  | <b>8</b>               |

**Books recommended:****Textbooks:**

1. David M. Pozar, "Microwave Engineering", Third Edition, Wiley India.

**Reference books:**

1. S. Y. Liao , “Microwave Devices & Circuits”, PHI 2nd Edition
2. R. Ludwig and G. Bogdanov, “RF Circuit Design, Theory and Applications”, Pearson, 2nd Edition.
3. B. R. Vishvakarma, R U Khan, M K. Meshram, “ Introduction to Microwave Measurements”
4. R.E.Collin, "Foundations for Microwave Engineering", Second edition, IEEE Press.

**Gaps in the syllabus (to meet Industry/Profession requirements):** Hands on experience on realtime industrial projects and management

**POs met through Gaps in the Syllabus:** PO11

**Topics beyond syllabus/Advanced topics/Design:** EMI-EMC due to electromagnetic radiations

**POs met through Topics beyond syllabus/Advanced topics/Design:** PO 6, PO 8

**Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure****Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher’s Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students’ Feedback on Course Outcome.

## Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 2 |   | 1 | 1 |   | 1 | 1 | 1 | 1  | 1  | 3  |                                  |    |    |
| CO2            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 2  | 1  | 3  |                                  |    |    |
| CO3            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 2  | 1  | 3  |                                  |    |    |
| CO4            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 | 1 | 2 | 2  | 1  | 3  |                                  |    |    |
| CO5            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 | 1 | 2 | 2  | 1  | 3  |                                  |    |    |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD2, CD8               |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1, CD2, CD4, CD5, CD8     |
| CD3     | Seminars  | CO3            | CD1, CD2, CD4, CD5, CD8     |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1, CD2, CD4, CD5, CD8     |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD1, CD2, CD4, CD5, CD8     |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9     | Simulation  |                |                             |

## COURSE INFORMATION SHEET

**Course code: EC324**

**Course title: Microwave Engineering Lab Pre-**

**requisite(s): Electromagnetic Fields and Waves Co-**  
**requisite(s):**

**Credits: L: 0 T: 0 P: 3 C: 1.5 Class**

**schedule per week: 03 Class: B. Tech.**

**Semester / Level: Fifth/Three**

**Branch: Electronics & Communication Engineering**

**Name of Teacher: ALL**

### **Course Objectives:**

This course enables the students:

|     |  |
|-----|--|
| 11. | To develop an understanding about the measurements of the various microwave passive components.                                |
| 12. | To develop an understanding about the measurements of the performance parameters of Microwave Crystal Detector and Gunn Diode. |
| 13. | To develop an ability to understand a planar microwave filter.   |
| 14. | To develop an ability to understand a planar microwave coupler .   |
| 15. | To develop an ability to understand a microstrip planar power divider  |

### **Course Outcomes:**

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Demonstrate understanding of the measurements of the various microwave passive components.                                |
| CO2 | Demonstrate understanding of the measurements of the performance parameters of Microwave Crystal Detector and Gunn Diode. |
| CO3 | Design a planar microwave filter.   |
| CO4 | Design a planar microwave coupler and power divider   |
| CO5 | Design a microstrip planar power divider  |



## Syllabus

### List of Compulsory experiments:

**1. Name of the Experiment: Rectangular Waveguide**

AIM-1: To Determine the Rectangular Waveguide Parameters

**2. Name of the Experiment: Waveguide T-Junctions**

AIM-1: To Find out the Coupling Coefficients of E-plane and H-plane Tee.

**3. Name of the Experiment: Magic Tee**

AIM-1: To Find out the Coupling Coefficients and Isolation of Magic Tee

**4. Name of the Experiment: Multi Hole Direction Coupler**

AIM-1: To Find out the Coupling Factor, Directivity and Insertion Loss of a Multi Hole Direction Coupler

**5. Name of the Experiment: Three Port Circulator**

AIM-1: To Find out the Coupling Coefficients and Isolation of a three port Circulator

**6. Name of the Experiment: Phase Shifter**

AIM 1: To Find out the Isolation of an Isolator and amount of phase shift of a phase shifter

**7. Name of the Experiment: Variable Attenuator**

AIM 1: To Determine the Attenuation of a Variable Attenuator

**8. Name of the Experiment:, Design of rectangular micro strip patch antenna using IE3D**

AIM 1: To Examine the square law characteristics of a Microwave Crystal Detector

**9. Name of the Experiment: Microstrip Low Pass Filter**

AIM 1: Using the IE3D, Design a low pass filter whose input and output are matched to a  $50 \Omega$  impedance and that meets the following specifications: cut-off frequency of 3 GHz, equiripple of 0.5 dB, and rejection of at least 25 dB at approximately 1.5 times the cut-off frequency. Assume a dielectric material that results in a phase velocity of 60 % of the speed of light.

**10. Name of the Experiment:, Branch-line Quadrature Hybrid Junction**

AIM 1: Using the IE3D, Design a  $50 \Omega$  branch-line quadrature hybrid junction, and plot the scattering parameter magnitudes from  $0.5f_0$  to  $1.5f_0$  where  $f_0$  is the design frequency.

**11. Name of the Experiment:, Microstrip Power Divider**

AIM 1: Using the IE3D, Design a 3 dB equal power divider and plot the scattering parameter magnitudes from  $0.5f_0$  to  $1.5f_0$  where  $f_0$  is the design frequency

**List of Optional experiments:**

**1. Name of the Experiment:, X-band Pyramidal Horn Antenna**

AIM 1: To Determine the Power gain, Radiation Pattern and 3dB Beamwidth of a X-band Pyramidal Horn Antenna

**2. Name of the Experiment:, KU- band Pyramidal Horn Antenna**

AIM 1: To Determine the Power gain, Radiation Pattern and 3dB Beamwidth of a KU-band Pyramidal Horn Antenna.

**3. Name of the Experiment:, Microstrip Antenna**

AIM 1: To Determine the Power gain, Radiation Pattern and 3dB Beamwidth of a Microstrip patch Antenna.

**4. Name of the Experiment:, Parabolic Disc Antenna**

AIM 1: Measurement of Power gain, Radiation Pattern and 3dB Beamwidth of a Parabolic Disc Antenna.

**5. Name of the Experiment:, Coaxial Line**

AIM 1: To Find out the Frequency and line parameters for a coaxial line.

**6. Name of the Experiment:, VHF Transmission Line**

AIM 1: To Find out the frequency and line Parameters of a two wire VHF transmission line.

**Text Book:**

1. "David M. Pozar, "Microwave Engineering", Third Edition, Wiley India.

**Reference Books:**

1. S. Y. Liao , "Microwave Devices & Circuits", PHI 2<sup>nd</sup> Edition
2. R. Ludwig and G. Bogdanov, "RF Circuit Design, Theory and Applications", Pearson, 2<sup>nd</sup> Edition.
2. B. R. Vishvakarma, R U Khan, M K. Meshram, " Introduction to Microwave Measurements"

3. R.E.Collin, "Foundations for Microwave Engineering", Second edition, IEEE Press.

**Gaps in the syllabus (to meet Industry/Profession requirements): NA**

**POs met through Gaps in the Syllabus: N/A.**

**Topics beyond syllabus/Advanced topics/Design: N/A**

**POs met through Topics beyond syllabus/Advanced topics/Design: N/A**

**Course Outcome (CO) Attainment Assessment tools & Evaluation procedure**

**Direct Assessment**

| <b>Assessment Tool</b>        | <b>% Contribution during CO Assessment</b> |
|-------------------------------|--|
| <b>Progressive Evaluation</b> | <b>(60)</b>                                |
| Attendance Marks              | <b>12</b>                                  |
| Day-to-day performance Marks  | <b>06</b>                                  |
| Lab Viva marks                | <b>20</b>                                  |
| Lab file Marks                | <b>12</b>                                  |
| Lab Quiz-I Marks              | <b>10</b>                                  |
| <b>End SEM Evaluation</b>     | <b>(40)</b>                                |
| Lab Quiz-II Marks             | <b>10</b>                                  |
| Lab performance Marks         | <b>30</b>                                  |

**Indirect Assessment –**

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

**Mapping of Course Outcomes onto Program Outcomes**

| <b>Course Outcome</b> | <b>Program Outcomes (POs)</b> |          |          |          |          |          |          |          |          |           |           |           | <b>Program Specific Outcomes (PSOs)</b> |          |          |
|-----------------------|-------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|---|----------|----------|
|                       | <b>1</b>                      | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>6</b> | <b>7</b> | <b>8</b> | <b>9</b> | <b>10</b> | <b>11</b> | <b>12</b> | <b>1</b>                                | <b>2</b> | <b>3</b> |
| <b>CO1</b>            | 3                             | 3        | 1        | 1        | 3        | 1        | -        | -        | 1        | 3         | 1         | 2         | 2                                       | 2        | 1        |
| <b>CO2</b>            | 3                             | 3        | 1        | 1        | 3        | 1        | -        | -        | 1        | 3         | 1         | 2         | 2                                       | 2        | 1        |

|            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <b>CO3</b> | 3 | 3 | 3 | 2 | 3 | 1 | - | - | 1 | 3 | 1 | 3 | 2 | 2 | 1 |
| <b>CO4</b> | 3 | 3 | 3 | 2 | 3 | 1 | - | - | 1 | 3 | 1 | 3 | 2 | 2 | 1 |
| <b>CO5</b> | 3 | 3 | 3 | 2 | 3 | 1 | - | - | 1 | 3 | 1 | 3 | 2 | 2 | 1 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods:**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD5 ,CD8                      |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1, CD5,CD8                       |
| CD3            | Seminars/ Quiz (s)  | CO3                   | CD1, CD5,CD8, CD9                  |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1, CD5, CD9                      |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1, CD5, CD9                      |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

## **COURSE INFORMATION SHEET**

**Course code: EC325**

**Course title: Antenna and Wave Propagation**

**Pre-requisite(s): Knowledge of Electromagnetic theory, Basic understanding of Network Theorem**

**Co- requisite(s): Electromagnetic Theory**

**Credits: L:3 T :0 P :0 C:3**

**Class schedule per week: 03/week**

**Class: B. Tech**

**Semester / Level: Fifth**

**Branch: ECE**

**Name of Teacher:**

### **Course Objectives**

This course enables the students:

|    |  |
|----|--|
| 1. | To impart knowledge on the fundamental antenna parameters .  |
| 2. | To develop the concept of mechanism of radio wave propagation and applications.  |
| 3. | To Analyze the concepts associated with operating principles of antenna theory, antenna performance, operation ,classification and applications. |
| 4. | To explain the concept and basic principles associated with the implementation of antenna arrays.  |

|    |  |
|----|--|
| 5. | To Apply the Antenna measurement techniques using microwave equipment setup. |
|----|--|

### Course Outcomes

After the completion of this course, students will be:

|     |  |
|-----|--|
| CO1 | Understand the basic radiation mechanism and antenna parameters. |
| CO2 | Design and characterize the various antenna arrays               |
| CO3 | Analyze the wire antennas and aperture antennas.                 |
| CO4 | Apply the knowledge on the measurements of Antenna parameters.   |
| CO5 | Understand the concept of the wave propagation in free space.    |

### SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <b>Module – I</b><br><b>Antenna Fundamentals:</b><br>Radiation mechanism - single wire, two wire, dipole and current distribution on thin wire, Radiated field components - Hertzian dipole, Half wave Dipole and Monopole Antenna.<br><b>Antenna Parameters:</b> Radiation Pattern, Beam Width, Radiation Power Density, Directivity and Gain, Bandwidth, Polarization, Input Impedance, Efficiency, Antenna Effective Length and Area, Antenna Temperature, Reciprocity Principle.<br>Problem solving . | <b>10</b>              |
| <b>Module – II</b><br><b>Antenna Arrays:</b><br>Linear Array - Two element array, N-element linear array- Broadside array, End fire array- Directivity, Pattern Multiplication, Non-uniform excitation- Binomial Array, Problem solving   | <b>9</b>               |

|   |          |
|---|----------|
| <b>Module – III</b><br><b>Special Antennas:</b><br>Practical antennas VLF, LF, MF transmitting antennas ,resonant antennas & non resonant antennas , Wire Antennas- Small Loop Antenna, V-Antenna, Rhombic antenna, Helical antenna and Yagi-Uda antenna, Frequency Independent Antenna - Spiral and Log periodic antenna,<br><b>Aperture antennas</b> - Horn antenna, Parabolic Reflector antenna, Microstrip antenna. | <b>8</b> |
| <b>Module – IV</b><br><b>Antenna Measurements:</b><br>Measurement of antenna impedance , Pattern measurements, Measurement of Antenna Gain, Beam width , Radiation resistance , Antenna efficiency , Directivity -Polarization.   | <b>7</b> |
| <b>Module – V</b><br><b>Propagation of radio waves:</b><br>Mode of propagation Ground wave propagation, sky wave propagation Space wave propagation, atmospheric effects, structure of atmosphere General picture of ionosphere, and its effect on radio waves. skip distance, MUF, ionospheric propagation, Fading, Problem solving  | <b>6</b> |

**Text Books:**

1. E.C. Jordan & K.G. Balmain, Electromagnetic waves & Radiating Systems, PHI, 2007
2. .D. Kraus, R.J. Marhefka and Ahmad S Khan, Antennas and Wave Propagation, 4th Edition, Mc Graw Hill, 2010

**Reference Book:**

1. Antennas and Wave propagation by A.R.Harish, M.Sachidananda, Oxford University press ,Ist edition 2007,ISBN-13:978-0-19-568666-1,ISBN -10: 0-19-568666-7

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

1. Application of Simulation software /tools to design antenna for research and industrial requirements

**POs met through Gaps in the Syllabus**

4,5,9

**Topics beyond syllabus/Advanced topics/Design**

2. Antenna synthesis and modeling
3. Fabrication of antennas and Testing

**POs met through Topics beyond syllabus/Advanced topics/Design**

1,2,10,12

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcomes | Program Outcomes(POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|-----------------|-----------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                 | 1                     | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| <b>CO1</b>      | 3                     | 3 | 2 | 1 | 2 |   |   |   |   |    |    |    |                                  |    |    |
| <b>CO2</b>      | 3                     | 3 | 3 | 3 | 3 | 2 | 2 | 1 |   | 2  |    | 2  |                                  |    |    |
| <b>CO3</b>      | 3                     | 3 | 3 | 3 | 3 | 2 | 2 |   | 1 |    |    |    |                                  |    |    |
| <b>CO4</b>      | 1                     | 3 | 3 | 3 | 3 | 2 |   | 2 |   | 2  | 2  | 2  |                                  |    |    |
| <b>CO5</b>      | 1                     | 2 | 1 | 2 |   | 2 |   |   | 3 |    | 3  |    |                                  |    |    |

**Correlation Levels 1, 2 or 3 as defined below:**



1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD2, CD7,CD 8                 |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD2,CD5, CD4                       |
| CD3            | Seminars  | CO3                   | CD2, CD6,CD 8,CD9                  |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD4,CD5,CD6 ,CD7                   |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1,CD6 ,CD8,                      |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

**COURSE INFORMATION SHEET**

**Course Code: EC327**

**Course Title: Mobile and Cellular Communication**

**Pre-requisite(s):** Knowledge of Communication process, probability theory, basic understanding of interference and noise in communication process, basic understanding of communication media.

**Co-requisite(s):**N/A

**Credits:** L: 3 T: 0 P: 0 C: 3 **Class schedule per week:** 03/week

**Class:** B. Tech.

**Semester / Level:** Fifth/ Third

**Branch: Electronics & Communication Engineering Name of Teacher:**

**Course Objectives**

This course enables the students:

|   |   |
|---|---|
| 1 | To understand cellular concept, cellular architecture and evolution of different generations and standards for mobile cellular communication. |
| 2 | To comprehend the impact of interference on the cellular system capacity.   |
| 3 | To comprehend different channel parameters causing impairments in signal propagation.   |
| 4 | To understand impairment removal techniques in signal propagation   |
| 5 | An understanding of multiple access techniques to support mobile cellular communication   |

**Course Outcomes:**

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Explain cellular concept, cellular architecture and evolution of different generations and standards for mobile cellular communication. |
| CO2 | Analyze the impact of interference on the cellular system capacity.   |
| CO3 | Analyze different channel parameters causing impairments in signal propagation  |
| CO4 | Evaluate different methods of Channel impairments removal techniques.   |
| CO5 | Explain multiple access techniques to support mobile cellular communication   |

**SYLLABUS**

| <b>MODULE</b>  | <b>(NO. OF LECTURE HOURS)</b> |
|--|-------------------------------|
| <p><b>Module – I</b><br/>           The cellular fundamentals: cellular communication and frequency reuse, general architecture of a cellular system, channel assignment strategies, handoff in a cellular system. Evolution of mobile cellular communication: different generations of mobile cellular communication (1G, 2G, 2.5G, 3G and beyond), typical cellular standards (AMPS, GSM, GPRS, WCDMA, LTE, concept of LTE-advanced), 4G features and challenges, 5G vision.</p> | <b>10</b>                     |

|   |          |
|---|----------|
| <p><b>Module – II</b><br/>Interference and cellular system capacity: co-channel interference and adjacent channel interference, power control, inter-symbol interference, enhancing cellular system capacity (cell splitting, sectorization, smart antenna technique, link adaptation and small cell deployment).</p>   | <b>8</b> |
| <p><b>Module – III</b><br/>Signal propagation in mobile communication : mobile cellular environment, multipath propagation and fading, free space propagation model, propagation path loss, outdoor propagation models (Okumura model &amp; Hata model), indoor propagation models, power delay profile, channel parameters (delay spread, doppler spread, coherence bandwidth, coherence time, LCR and ADF).</p> | <b>8</b> |
| <p><b>Module – IV</b><br/>Diversity &amp; combining techniques: diversity mechanisms (space, time, frequency and polarization), diversity gain and array gain, combining techniques (SC, MRC, TC and EGC), concept of equalization.</p>   | <b>7</b> |
| <p><b>Module – V</b><br/>Multiple access schemes: duplexing schemes, FDMA, TDMA, SDMA, spread spectrum technique and CDMA, OFDMA, ALOHA and CSMA.</p>   | <b>7</b> |

**Text Book:**

1. Vijay K. Garg, “Wireless Communications and Networks”, Morgan Kaufmann Publishers an Imprint of Elsevier, USA 2009 (Indian reprint).

**Reference Books:**

1. Simon Haykin and Michael Moher, “Modern Wireless Communications”, Parson Education, Delhi, 2005.
2. Theodore S Rappaport, “Wireless Communication: Principles and Practice” Prentice Hall of India, New Delhi, 2006, 2/e.
3. Sanjay Kumar, “Wireless Communication the Fundamental and Advanced Concepts” River Publishers, Denmark, 2015 (Indian reprint).

**Gaps in the syllabus (to meet Industry/Profession requirements):** Current technological developments in the field

**POs met through Gaps in the Syllabus:** PO1 & PO12

**Topics beyond syllabus/Advanced topics/Design:** Current research findings in the field of mobile cellular communication.

**POs met through Topics beyond syllabus/Advanced topics/Design:** PO1 & PO12

**Course Outcome (CO) Attainment Assessment tools & Evaluation procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment –**

1. Student Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |   |   |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|---|---|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1                                | 2 | 3 |
| CO1            | 3                      | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2  | 1  | 2  | 3                                | 2 | 2 |
| CO2            | 3                      | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 2 | 2  | 1  | 1  | 3                                | 2 | 2 |
| CO3            | 3                      | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 2 | 2  | 1  | 1  | 1                                | 2 | 3 |

|            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <b>CO4</b> | 3 | 3 | 2 | 3 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 3 | 2 | 1 |
| <b>CO5</b> | 3 | 3 | 2 | 3 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 3 | 2 | 1 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of boards/LCD projectors/OHP projectors      | CO1                   | CD1,CD2,CD6, CD8                   |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1, CD2, CD6, CD8                 |
| CD3            | Seminars  | CO3                   | CD1, CD2, CD6, CD8                 |
| CD4            | Mini projects/Projects                                      | CO4                   | CD1, CD2, CD6, CD8                 |
| CD5            | Laboratory experiments/teaching aids                        | CO5                   | CD1,CD2,CD3, CD9                   |
| CD6            | Industrial/guest lectures                                   |                       |                                    |
| CD7            | Industrial visits/in-plant training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL materials and internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

**COURSE INFORMATION SHEET**

**Course code:** EC328

**Course title:** Mobile & Cellular Communication Lab

**Pre-requisite(s):** Knowledge of Communication process, probability theory, basic understanding of interference and noise in communication process, basic understanding of communication media.

**Co- requisite(s):**

**Credits:** L: 0 T: 0 P: 3 C: 1.5

**Class schedule per week:** 03 **Class:** B.

**Tech.**

**Semester / Level: Fifth/Third**

**Branch: Electronics & Communication Engineering**

**Name of Teacher: ALL**

**Course Objectives:**

This course enables the students:

|   |   |
|---|---|
| 1 | To explain GSM modem and the GPRS system, Spread Spectrum and 4G -LTE.                      |
| 2 | To explain <i>the cellular frequency reuse concept, interference and handover mechanism</i> |
| 3 | To understand path loss and in estimation of received signal power                          |
| 4 | To identify Performance parameters related to cellular communication                        |
| 5 | To explain MIMO system  |

**Course Outcomes:**

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Experiment for GSM modem ,GPRS system, Spread Spectrum and 4G -LTE                                      |
| CO2 | Demonstrate the working of <i>cellular frequency reuse concept, interference and handover mechanism</i> |
| CO3 | Design and Develop path loss models through simulation  |
| CO4 | To measure Performance parameters related to cellular communication                                     |
| CO5 | Demonstrate MIMO system   |

**Syllabus**

**List of Compulsory experiments:**

**1. Name of the Experiment: Understanding GSM Handset Setup**

AIM: Study the GSM modem and its different module for phone book access, setting up a call, sending SMS and identifying call history using AT commands.

**2. Name of the Experiment: Understanding Direct Sequence Spread Spectrum Technique**

AIM: Study of Direct Sequence Spread Spectrum Modulation and Demodulation process using Trainer Kit.

- 3. Name of the Experiment: Understanding 3G Mobile Communication System**  
AIM: To establish 3G Mobile Communication and observe SIM signal, switch fault and test various AT command on 3G terminal.
- 4. Name of the Experiment: Understanding 4G - VoLTE Smart Phone System**  
AIM: To establish 4G Communication and observe signal at various test points using Trainer kit.
- 5. Name of the Experiment: Measurement of received signal power in mobile cellular communication**  
AIM: Evaluate the impact of path loss for estimation of received signal power using Virtual Lab/MATLAB.
- 6. Name of the Experiment: Measurement of Signal to Interference and Noise Ratio** AIM: To Understand the concept of co-channel interference and evaluate Signal to Interference and Noise Ratio using Virtual Lab/MATLAB for Fading Channels.
- 7. Name of the Experiment: Understanding cellular frequency reuse concept**  
AIM: Finding the co-channel cells for a particular cell and finding the cell clusters within certain geographic area Virtual Lab/MATLAB.
- 8. Name of the Experiment: Downlink C/I ratio measurement**  
AIM: To understand the impact of many different parameters influencing the downlink C/I ratio like: Cell radius, Transmitter power of B.S, Frequency reuse, Sectoring, Shadowing, Base station height, Path loss exponent etc using Virtual Lab/MATLAB for Fading Channels.
- 9. Name of the Experiment: Understanding Handover Mechanism**  
AIM: To understand the Hard and Soft handover mechanism using Virtual Lab/MATLAB for Fading Channels.
- 10. Name of the Experiment: Analysis of wireless communication parameters**  
AIM: To study the outage probability, LCR & ADF in SISO for Selection Combining and MRC using Virtual Lab/MATLAB for Fading Channels.
- 11. Name of the Experiment: Analysis of delay spread for fading channel**  
AIM: To study the effect of delay spread on frequency selectivity channel using Virtual Lab/MATLAB.
- 12. Name of the Experiment: Channel Capacity evaluation for MIMO System** AIM: To obtain and compare the channel capacity for SISO, SIMO, MISO and MIMO system Using Virtual Lab/MATLAB.

**Text Book:**

1. Theodore S Rappaport, "Wireless Communication: Principles and Practice" Prentice Hall of India, New Delhi, 2006, 2/e.

**Reference Books:**

1. Sanjay Kumar, "Wireless Communication the Fundamental and Advanced Concepts" River Publishers, Denmark, 2015 (Indian reprint).
2. J. Schiller, "Mobile Communication" 2/e, Pearson Education, 2012.

Gaps in the syllabus (to meet Industry/Profession requirements): NA

POs met through Gaps in the Syllabus: N/A.

Topics beyond syllabus/Advanced topics/Design: N/A

POs met through Topics beyond syllabus/Advanced topics/Design: N/A

### Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

#### Direct Assessment

| Assessment Tool               | % Contribution during CO Assessment |
|-------------------------------|-------------------------------------|
| <b>Progressive Evaluation</b> | <b>(60)</b>                         |
| Attendance Marks              | <b>12</b>                           |
| Day-to-day performance Marks  | <b>06</b>                           |
| Lab Viva marks                | <b>20</b>                           |
| Lab file Marks                | <b>12</b>                           |
| Lab Quiz-I Marks              | <b>10</b>                           |
| <b>End SEM Evaluation</b>     | <b>(40)</b>                         |
| Lab Quiz-II Marks             | <b>10</b>                           |
| Lab performance Marks         | <b>30</b>                           |

#### **Indirect Assessment –**

1. Student Feedback on Course Outcome

#### **Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |   |   |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|---|---|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1                                | 2 | 3 |
| CO1            | 3                      | 3 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 2  | 2  | 2  | 2                                | 2 | 1 |



|            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <b>CO2</b> | 3 | 3 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| <b>CO3</b> | 3 | 2 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| <b>CO4</b> | 3 | 3 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| <b>CO5</b> | 3 | 2 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods:**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD5                           |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1, CD5, CD9                      |
| CD3            | Seminars/ Quiz (s)  | CO3                   | CD1, CD5, CD9                      |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1, CD5, CD9                      |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1, CD5, CD9                      |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

**COURSE INFORMATION SHEET**

**Course Code: EC 329**

**Course Title: Information Theory and Coding**

**Pre-requisite(s):** Knowledge of digital electronics, probability theory, basic understanding of communication system.

**Co- requisite(s):**

**Credits:** L: 3 T: 0 P: 0 C:3

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: Fifth/Three**

**Branch: Electronics & Communication Engineering Name  
of Teacher:**

### Course Objectives

This course envisions to impart to students to:

|     |   |
|-----|---|
| 6.  | An understanding of the fundamental knowledge of information  |
| 7.  | An understanding of channel capacity to achieve efficient as well as reliable communication.                            |
| 8.  | An understanding of various Source and Channel Coding Techniques  |
| 9.  | Fundamental understanding on block codes, cyclic codes and convolutional codes, also explore its practical challenges.  |
| 10. | An ability to design and provide solutions for practical low cost, efficient, reliable and secure communication system. |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Have an ability to measure information from a discrete as well as continuous source   |
| CO2 | Have an ability to compute the capacity of discrete and continuous time channels in presence and absence of noise.  |
| CO3 | Have an ability to measure and evaluate entropy for lossy & lossless source coding..  |
| CO4 | Have an ability to ensure error free transmission of a discrete/ continuous message source using suitable channel coding techniques like linear block codes, cyclic codes, convolution codes and turbo codes. |

|     |   |
|-----|---|
| CO5 | Have an ability to provide practical solutions and apply the subject expertise for the well fare of society |
|-----|---|

## SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b><br/> <b>Source Coding:</b><br/>           Information measure, Entropy, Differential Entropy, Conditional Entropy, Relative Entropy, Information rate, Mutual Information, Shannon’s Source Coding Theorem<br/>           Prefix Coding, Huffman Coding, Shannon-Fano Coding, Arithmetic Coding, Ziv Algorithm, Rate Distortion Theory.</p>  | 10                     |
| <p><b>Module – II</b><br/> <b>Channel Capacity &amp; Coding:</b><br/>           Channel Coding Theorem, Markov Sources, Discrete Channel with discrete Noise, BSC, BEC, Capacity of a Gaussian Channel, channel capacity for MIMO system Bandwidth-S/N Trade-off.</p>   | 10                     |
| <p><b>Module – III</b><br/> <b>Block Codes:</b><br/>           Galois Fields, Hamming Weight and Hamming Distance, Linear Block Codes<br/>           Encoding and decoding of Linear Block-codes, Parity Check Matrix, Bounds for block codes, Hamming Codes, Syndrome Decoding.</p>  | 7                      |
| <p><b>Module – IV</b><br/> <b>Cyclic Codes:</b><br/>           Introduction to cyclic code, Method for generating Cyclic Codes, Matrix description of Cyclic codes, Cyclic Redundancy Check (CRC) codes, Circuit implementation of cyclic codes, Burst error correction, BCH codes.</p>   | 7                      |
| <p><b>Module – V</b><br/> <b>Convolutional Codes:</b><br/>           Introduction to Convolutional Codes, Polynomial description of Convolutional Codes<br/>           Generating function, Matrix description of Convolutional Codes, Viterbi Decoding<br/>           Convolutional code, Introduction to Turbo Code, Introduction to Cryptography<br/>           Overview of Encryption Techniques.</p> | 7                      |

**Text Books:**

1. “Information Theory, Coding & Cryptography”, by Ranjan Bose, TMH, Second Edition.
2. “Communication Systems”, by S. Haykin, 4th Edition, Wiley-Publication.

**Reference Books:**

1. “Elements of Information Theory” by Thomas M. Cover, J. A. Thomas, Wiley-Inter science Publication.
2. “Error Correction Coding Mathematical Methods and Algorithms” by Todd K. Moon, Wiley India Edition.
3. “Cryptography and Network Security”, Fourth Edition, by William Stallings

**Gaps in the Syllabus (to meet Industry/Profession requirements)****POs met through Gaps in the Syllabus:****Topics beyond syllabus/Advanced topics/Design****POs met through Topics beyond syllabus/Advanced topics/Design: PO1****Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure****Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher’s Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students’ Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 1 |   |   |   |   |   |   |   |    |    |    | 3                                | 2  | 1  |
| CO2            | 3                      | 3 |   |   |   | 1 |   |   |   |    |    |    | 3                                | 2  | 2  |
| CO3            | 3                      | 3 |   |   |   | 1 |   |   |   |    |    |    | 3                                | 2  | 1  |

|            |   |   |   |   |  |   |   |  |  |  |  |   |   |   |   |
|------------|---|---|---|---|--|---|---|--|--|--|--|---|---|---|---|
| <b>CO4</b> | 3 | 3 | 1 | 3 |  | 1 | 1 |  |  |  |  | 2 | 3 | 2 | 3 |
| <b>CO5</b> | 3 | 3 | 1 | 3 |  | 1 | 1 |  |  |  |  | 2 | 3 | 2 | 2 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD8                           |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1 ,CD8                           |
| CD3            | Seminars  | CO3                   | CD1, CD8                           |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1, CD8                           |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1,CD8                            |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

## COURSE INFORMATION SHEET

**Course code:** EC331

**Course title:** Issues in Nanoscale CMOS Design

**Pre-requisite(s):** EC101 Basics of Electronics and Communication Engineering, EC201 Electronic Devices Co- requisite(s):

**Credits:** L: 3 T: 0 P: 0 C: 3

**Class schedule per week:** 03 **Class:** B.

Tech.

**Semester / Level:** V/03

**Branch:** ECE **Name**

**of Teacher:**

### Course Objectives

This course enables the students to:

|    |   |
|----|---|
| 1. | Understand trend of technology scaling and its impact on device and circuit performance.                                |
| 2. | Comprehend pitfalls in CMOS circuit and apply the perceived knowledge.  |
| 3. | Appraise and analyse the variability and reliability issues.  |
| 4. | Perceive the sources of variation and evaluate variation prevention techniques.   |
| 5. | Apprehend the advantages and pitfalls of silicon-on-insulator technology and create/design SOI device using TCAD tools. |

### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Describe and illustrate the technology scaling and its impact on device and circuit performance. |
| CO2 | Sketch and explain the pitfalls in CMOS circuits.  |
| CO3 | Diagram and explain the variability and reliability issues.                                      |
| CO4 | Summarize and schematize the sources of variation, assess the variation prevention techniques.   |
| CO5 | Design and schematize SOI devices and write issues in SOI technology.                            |

## SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b><br/> <b>Technology Scaling and its impact on device and circuit performance:</b><br/>           Transistor Scaling, Interconnect Scaling, ITRS; Impacts of Technology Scaling on Design, Physical Limits of Technology Scaling, tunnelling current through thin oxides, Poor I-V characteristics due to short-channel effects, mobility degradation and velocity saturation, channel length modulation, substrate current-induced body effect (SCBE), drain-induced barrier lowering (DIBL).</p> | 8                      |
| <p><b>Module – II</b><br/> <b>Pitfalls in CMOS Circuit:</b><br/>           Threshold drops, Ratio failures, Leakage currents, leakage prevention techniques; Charge sharing, Power supply noise, Hot spots, Minority carrier injection, Backgate coupling, Diffusion input noise sensitivity, Process sensitivity, Domino Noise Budgets: Charge leakage, Charge sharing, Capacitive coupling, Noise feedthrough, Process corner effects, Soft errors; Manufacturing Issues.</p>                                       | 8                      |
| <p><b>Module – III</b><br/> <b>Variability and Reliability Issues:</b><br/>           Variability: Process variation, Supply voltage, Operating temperature, Design Corners; Reliability: Reliability Terminology, Oxide Wearout, Hot Carriers, Negative bias temperature instability (NBTI), Time-dependent dielectric breakdown (TDDB); Interconnect Wearout: Electromigration, Self-Heating, Soft Errors, Overvoltage Failure, Latchup and its prevention technique.</p>   | 8                      |



|   |          |
|---|----------|
| <p><b>Module – IV</b><br/> <b>Sources of Variation and Variation Prevention Techniques:</b><br/> Channel Length Variation, linewidth variation, line edge roughness, proximity effect, orientation Effect, topography effect, Threshold voltage variation, random dopant fluctuations (RDF), Oxide Thickness variation, Layout Effects, acrosschip mobility variation; Impact of variation on Device and Circuit Performance, Variation in Delay, Variation in Power, Variation in Energy, Malfunctioning Device and Circuits, Matched Delays, Variation-Tolerant Design.</p> | <b>8</b> |
| <p><b>Module – V</b><br/> <b>Issues in SOI Technology:</b> Types of Silicon-on-Insulator Devices, Partially-depleted Silicon-on-Insulator device, Fully-depleted Silicon-on-Insulator device, pitfalls of Partially-depleted Silicon-on-Insulator device: history effect, pass-gate leakage, Self-heating, implications for circuit styles in Partially-depleted Siliconon-Insulator devices, advantages of Silicon-on-Insulator CMOS process.</p>  | <b>8</b> |

**Textbooks:**

1. Neil H. E. Weste and David Harris, “CMOS VLSI Design: A Circuits and Systems Perspective”, 4th International Edition, Pearson Education, Inc., 2011.
2. Y. Taur and T.H. Ning. Fundamentals of Modern VLSI Devices. Cambridge University Press, NY, USA, 2/e, 2016.

**Reference books:**

1. J. M. Rabaey, A. Chandrakasan, B. Nikolic, “Digital Integrated Circuits: A Design Perspective,” 2<sup>nd</sup> ed., Pearson Education, 2016.
2. Alice Wang, Benton H. Calhoun, A. P. Chandrakasan “Sub-threshold Design for Ultra LowPower Systems”, Springer, 2006, ISBN-13: 978-0387335155.

**Gaps in the syllabus (to meet Industry/Profession requirements):**

1. Hands-on-practical for CMOS IC (Integrated Circuit) fabrication.

**POs met through Gaps in the Syllabus:**

10

**Topics beyond syllabus/Advanced topics/Design:**

N/A

**POs met through Topics beyond syllabus/Advanced topics/Design:**

10

**Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO2            | 3                      | 3 | 2 | 3 | 3 | 3 | 2 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO3            | 3                      | 3 | 2 | 3 | 3 | 3 | 2 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO4            | 3                      | 3 | 2 | 3 | 3 | 2 | 2 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO5            | 3                      | 3 | 2 | 3 | 3 | 2 | 2 |   |   | 3  |    | 3  | 3                                | 2  | 1  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD7, CD 8              |
| CD2     | Tutorials/Assignments                   | CO2            | CD1 and CD9                 |
| CD3     | Seminars                                | CO3            | CD1, CD2 and CD3            |
| CD4     | Mini Projects/Projects                  | CO4            | CD1 and CD2                 |
| CD5     | Laboratory Experiments/Teaching Aids    | CO5            | CD1 and CD2                 |
| CD6     | Industrial/Guest Lectures               |                |                             |
| CD7     | Industrial Visits/In-plant Training     |                |                             |

|     |   |  |  |
|-----|---|--|--|
| CD8 | Self- learning such as use of NPTEL Materials and Internets |  |  |
| CD9 | Simulation  |  |  |

**COURSE INFORMATION SHEET**

**Course Code: EC333**

Course title: **Sensors and Transducers** Pre-requisite(s):

Co- requisite(s):

Course type: Elective

Credits: L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B.E

Semester / Level: VI

Branch: ECE Name

of Teacher:

**Course Objectives**

This course envisions to impart to students to:

|     |  |
|-----|--|
| 11. | To describe the operation of various sensors and their application   |
| 12. | To select an appropriate sensor for a given application              |
| 13. | Design a smart sensor using conventional sensors and microcontroller |
| 14. | Compare analog and digital transducer.                               |
| 15. | To discuss the latest technology in sensor development               |

**Course Outcomes**

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Understand the principle of operation of different sensors and their applications |
| CO2 | Classify sensors on different basis   |
| CO3 | Differentiate between smart sensor and conventional sensor                        |
| CO4 | Demonstrate the operation of various digital transducer                           |
| CO5 | Be updated on the recent trends in sensor technologies.                           |

## SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <b>Module – I</b><br><b>Introduction</b><br>Introduction about sensors and transducers, Principles of operation and their classification, characteristics of sensors, Errors in measurement.   | <b>6</b>               |
| <b>Module – II</b><br><b>Resistive and Inductive Transducer</b><br>Resistive transducers: Potentiometers, metal and semiconductor strain gauges and signal conditioning circuits, strain gauge applications: load and torque measurement, RTD, Thermistor, LDR,<br>Self and mutual inductive transducers, LVDT, RVDT, eddy currents transducer . | <b>10</b>              |
| <b>Module – III</b><br><b>Capacitive and Piezoelectric transducer</b><br>The parallel plate capacitive sensor, variable permittivity capacitive sensor, stretched diaphragm variable capacitive transducer, piezoelectric transducers and their signal conditioning, photoelectric transducers, Hall Effect sensors.                             | <b>10</b>              |

|   |          |
|---|----------|
| <b>Module – IV</b><br><br><b>Smart Sensor</b><br>Principle, design approach, interface design, configuration supports, communication in smart transducer network. HART protocol.                            | <b>8</b> |
| <b>Module – V</b><br><br><b>Recent trends in sensor technology</b><br>Digital transducer, Principles and applications of Fibre optic sensor, MEMS sensor, Bio sensor, Silicon sensor, sensors for robotics. | <b>6</b> |

**Text Books:**

1. Sensors and Transducers, by D. Patranabis. 2<sup>nd</sup> Edition
2. Elctrical & Electronics Measurements and Instrumentation by A.K Sawhney, Dhanpat Rai & Sons.
3. Transducers and Instrumentation, by Murthy D. V. S., Prentice Hall, 2<sup>nd</sup> Edition, 2011.

**Reference Books:**

1. Sensor and signal conditioning by John G. Webster, Wiley Inter Science, 2<sup>nd</sup> edition, 2008

**Gaps in the syllabus (to meet Industry/Profession requirements): N/A**

**POs met through Gaps in the Syllabus: PO8 will be met though report-writing/presentationbased assignment**

**Topics beyond syllabus/Advanced topics/Design: Teaching through paper/ latest standards in data communication**

**POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through paper**

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |

## Indirect Assessment

### 1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 2 | 3 | 3 |   | 3 | 1 | 2 | 3 | 3  | 3  | 3  | 2                                | 2  | 1  |
| CO2            | 2                      | 3 | 3 | 3 |   | 3 | 1 | 2 | 3 | 3  | 3  | 2  | 2                                | 2  | 1  |
| CO3            | 2                      | 3 | 3 | 3 |   | 3 | 1 | 3 | 3 | 3  | 3  | 2  | 2                                | 2  | 1  |
| CO4            | 2                      | 2 | 3 | 3 | 1 | 3 | 1 | 2 | 3 | 3  | 3  | 2  | 2                                | 2  | 1  |
| CO5            | 2                      | 3 | 3 | 2 | 1 | 3 | 1 | 2 | 3 | 3  | 3  | 2  | 2                                | 2  | 1  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, and CD 8               |
| CD2     | Tutorials/Assignments                   | CO2            | CD1, and CD 8               |
| CD3     | Seminars                                | CO3            | CD1, and CD 8               |
| CD4     | Mini Projects/Projects                  | CO4            | CD1, and CD 8               |
| CD5     | Laboratory Experiments/Teaching Aids    | CO5            | CD1, and CD 8               |

|     |   |  |  |
|-----|---|--|--|
| CD6 | Industrial/Guest Lectures                                   |  |  |
| CD7 | Industrial Visits/In-plant Training                         |  |  |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |  |  |
| CD9 | Simulation  |  |  |

### **COURSE INFORMATION SHEET**

Course code: **EC335**

Course title: **Consumer Electronics**

Pre-requisite(s): EC101 Basics of Electronics and Communication Engineering, Co-requisite(s):

Credits: L:3 T:0 P:0

Class schedule per week: 0x

Class: B. E. Semester /

Level:0X Branch:

Name of Teacher:

#### **Course Objectives**

This course enables the students to:

|    |  |
|----|--|
| 1. | To describe the operating principles of different types of microphones and audio systems     |
| 2. | To explain the process of composite video signal transmission and reception.                 |
| 3. | To familiarize with various devices related to telecommunication system.                     |
| 4. | To Demonstrate the working of household electronics equipment with sketches of block diagram |
| 5. | To illustrate the working principles of various consumer electronic devices.                 |

#### **Course Outcomes**

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Demonstrate technical specification of Audio systems and its operation.   |
| CO2 | Identify and explain working of various colour analog and digital TV  |
| CO3 | Able to understand different telecommunication technology.  |
| CO4 | Able to understand the working of different household appliances.   |
| CO5 | Explain the basic functions of various consumer electronic goods and trouble shoots consumer electronics products |

## SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <b>Module – I</b><br>Introduction to audio recorders and players<br>Microphones, types of microphones, Magnetic Tape recorder, Audio compact disc system, High fidelity Audio system, Stereo sound system, Loudspeaker, Public address system, Magnetic sound recording.   | <b>7</b>               |
| <b>Module – II</b><br>Introduction to Radio and TV Transmission & Reception<br>FM and AM radio transmission and reception, Block diagram of TV transmitter, Television studios and Equipment, Antenna for TV transmitter, Block diagram of TV receiver, TV camera tube, Persistence of vision, Scanning, Synchronization, CCTR-B System, Composite video signal, Bandwidth of TV signal, Audio signal modulation, TV channel, Television Rx antenna, Feeder cable, Balun T/F, Monochrome picture tube, Black & white TV Rx, Colour TV signal, Colour TV Rx, PAL, NTSC, SECAM signal, compatibility, CCTV, Cable TV, Dish TV, HDTV, 3D TV | <b>10</b>              |



|   |           |
|---|-----------|
| <b>Module – III</b><br>Introduction to Telecommunication Systems:<br>Basics of Telephone system, Caller ID Telephone, Intercoms, Cordless Telephones, Cellular mobile systems, 2G, 3G and 4G technolog.   | <b>10</b> |
| <b>Module – IV</b><br>Introduction to Home Electronics:<br>Cord less Door Bell, Inverter, Digital Camera system, Microwave ovens, Washing Machines, Air Conditioners and Refrigerators.   | <b>7</b>  |
| <b>Module – V</b><br>Digital watch, Calculators, An electronic guessing game, Cordless Telephone, Mobile telephone, Cellular telephone, Battery telephone, Battery Eliminator, Battery charger, DC supply, DC supply operational amplifier, IC regulator, UPS, Inverter, Decorative Lighting, Microwave oven, LCD tunes with alarm. | <b>6</b>  |

**Text books:**

1. S.P. Bali, Consumer Electronics, Pearson Education,
2. R.R.Gulati, “Monochrome and Color Television”, New Age International Publisher
3. B.R. Gupta and V. Singhal, “Consumer Electronics”, S.K. Kataria & Sons,

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

**POs met through Gaps in the Syllabus**

**Topics beyond syllabus/Advanced topics/Design**

**POs met through Topics beyond syllabus/Advanced topics/Design**

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher’s Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 2 | 3 | 2 |   |   | 1 | 2 | 3  | 2  | 1  |                                  |    |    |
| CO2            | 3                      | 3 | 2 | 3 | 1 |   |   | 1 | 2 | 3  | 2  | 1  |                                  |    |    |
| CO3            | 3                      | 3 | 2 | 2 | 1 |   |   | 1 | 2 | 3  | 2  | 1  |                                  |    |    |
| CO4            | 3                      | 3 | 2 | 3 | 2 |   |   | 1 | 2 | 3  | 2  | 1  |                                  |    |    |
| CO5            | 3                      | 3 | 2 | 3 | 2 |   |   | 1 | 2 | 3  | 2  | 1  |                                  |    |    |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1 and CD 8                |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1 and CD 8                |
| CD3     | Seminars  | CO3            | CD1 and CD 8                |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1 and CD 8                |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD1 and CD 8                |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9     | Simulation  |                |                             |

## **COURSE INFORMATION SHEET**

Course code: **EC351**

Course title: **Fiber Optic Communication**

Pre-requisite(s): Knowledge of Semiconductor Devices, Electromagnetic Theory

Co-requisite(s): None

Credits:           L: 3   T: 0   P: 0   C: 3

Class schedule per week: 03

Class: B. Tech

Semester / Level: 06

Branch: ECE

Name of Teacher:

### **Course Objectives**

This course enables the students:

|    |  |
|----|--|
| 1. | To demonstrate the different generations, elements required to establish the fiber optic link, the losses and the dispersion effects in fiber optic communication.   |
| 2. | To identify the types of couplers, optical sources for fiber optic communication system.   |
| 3. | To identify the types of photodiode, optical receivers in fiber optic communication system and understand system performance through the link power budget and dispersion limitations of digital fiber optic link. |

|    |  |
|----|--|
| 4. | To understand WDM, optical amplifiers, optical switching in fiber optic networks.              |
| 5. | To understand different network topologies and nonlinear effects in fiber optic communication. |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Identify the elements required to establish the fiber optic link and determine the losses and the dispersion effects in fiber optic communication.  |
| CO2 | Choose the appropriate couplers, optical sources for fiber optic communication system.  |
| CO3 | Select the types of photodiodes/optical receivers in fiber optic communication system and assess the system performance through the link power budget and dispersion limitations of digital fiber optic link. |
| CO4 | Implement the WDM, optical amplifiers, optical switching for fiber optic networks.  |
| CO5 | Analyze the different network topologies and nonlinear effects in fiber optic communication.  |

### Syllabus

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <b>Module – I</b><br>Generations of optical communication, Basic elements of an optical fiber transmission link, Fiber types and fiber parameters, Fiber material and fabrication methods, Ray and modal analysis in Step index(SI) and Graded index(GI) fibers, Modes in SI&GI fibers , Power flow in step index fibers, Attenuation mechanisms in optical fibers, Dispersion effects in optical fibers. | <b>10</b>              |
| <b>Module – II</b><br>Structure and materials of LED and LD sources, Operating characteristics and modulation capabilities of the LED and LD sources, Source to Fiber Power launching and coupling, Lensing scheme for coupling improvement, Fiber to fiber coupling and alignment methods, Splicing techniques, Fiber Connectors.  | <b>10</b>              |

|   |                 |
|---|-----------------|
| <p><b>Module – III</b></p> <p>Principle of PIN photodiode and Avalanche photodiode, Noise in photodetectors, Detector response time, Photodiode materials, Optical receiver configuration and performance, Pre-amplifier design for optical receiver, analog and digital receiver. Optical link design - BER calculation, quantum limit, power penalties, Point to point transmission links, Link power and rise time budget.</p> | <p><b>7</b></p> |
| <p><b>Module – IV</b></p> <p>WDM and DWDM operational principles, Optical couplers, Fiber Bragg grating, AWG router/multiplexer, Add/Drop Multiplexer, Optical amplifiers, Amplification mechanism of semiconductor optical amplifier(SOA) and Erbium doped fiber amplifier (EDFA), EDFA architecture, Optical switches, Wavelength converters.</p>   | <p><b>8</b></p> |
| <p><b>Module – V</b></p> <p>SONET/ SDH architecture, SONET/ SDH Rings, All optical WDM networks, Single hop and multihop networks, Nonlinear effects on network performance, SRS, SBS, Self-phase modulation(SPM), Soliton pulses, Soliton based communication.</p>   | <p><b>5</b></p> |

**Text books:**

1. “Optical Fiber Communications” G.Keiser, 3/e, McGraw Hill
2. “Optical Fiber Communication”, J. M. Senior, PHI, 2<sup>nd</sup> Ed.
3. “Optical Networking and WDM”, Walter Goralski, Tata McGraw-Hill

**Ref. Books:**

1. “Introduction to Fiber Optics”, Ghatak & Thyagarajan, Cambridge University press.
2. “Optical Communications”, J.H.Franz & V.K.Jain Narosa Publishing House.
3. “Fiber Optics Communication”, Harold Kolimbris, Pearson Education.
4. “Fundamentals of Fiber optics in telecommunication and sensor systems”, B.P.Pal, New age International (P) Ltd.
5. “Optical Communication Networks”, B.Mukherjee McGraw Hill.

**Gaps in the syllabus (to meet Industry/Profession requirements):**

**POs met through Gaps in the Syllabus:**

**Topics beyond syllabus/Advanced topics/Design:****POs met through Topics beyond syllabus/Advanced topics/Design: PO6****Course Delivery Methods**

|     |   |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors      |
| CD2 | Assignments   |
| CD3 | Laboratory experiments/teaching aids/Seminars               |
| CD4 | Industrial/guest lectures                                   |
| CD5 | Industrial visits/in-plant training                         |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation  |

**Course Outcome (CO) Attainment Assessment tools & Evaluation procedure****Direct Assessment**

| Assessment Tool           | % Contribution during CO Assessment |
|---------------------------|-------------------------------------|
| Mid Sem Examination Marks | 25                                  |
| End Sem Examination Marks | 60                                  |
| Assignment / Quiz (s)     | 15                                  |

**Indirect Assessment**

1. Student Feedback on Course Outcome

**Mapping between Course Outcomes and Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 2 | 2 | 3 | 1 | 2 |   | 1 | 2  | 3  | 1  | 3                                | 2  | 2  |
| CO2            | 3                      | 3 | 2 | 2 | 3 | 1 | 2 |   | 1 | 2  | 3  | 2  | 3                                | 2  | 2  |
| CO3            | 3                      | 3 | 2 | 3 | 3 | 1 | 2 |   | 1 | 2  | 3  | 2  | 3                                | 2  | 2  |
| CO4            | 3                      | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2  | 3  | 2  | 3                                | 2  | 3  |

|            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <b>CO5</b> | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 3 |
|------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Mapping between Course Outcomes and Course Delivery Method**

| <b>Course Outcomes</b> | <b>Course Delivery Method</b> |
|------------------------|-------------------------------|
| CO1                    | CD1, CD2, CD3, CD6, CD7       |
| CO2                    | CD1, CD2, CD3, CD6, CD7       |
| CO3                    | CD1, CD2, CD3, CD6, CD7       |
| CO4                    | CD1, CD2, CD3, CD6, CD7       |
| CO5                    | CD1, CD2, CD3, CD6, CD7       |

**COURSE INFORMATION SHEET**

**Course code: EC353**

**Course title: Pulse, Digital and Switching System**

**Pre-requisite(s): Basic Electronic Engineering, Analog Circuits**

**Co-requisite(s): None**

**Credits: L: 3 T: 0 P: 0 C: 3.0**

**Class schedule per week: 03**

**Class: B. Tech**

**Semester / Level: 05**

**Branch: ECE**

**Name of Teacher:**

**Course Objectives**

This course enables the students:

|    |  |
|----|--|
| 1. | To understand RC filter circuits, attenuators, RL, RLC circuits, ringing, clipper and clampers |
| 2. | To understand Non-Linear Wave Shaping  |
| 3. | To realize various Multivibrators using transistors, op-amp and other discrete components      |
| 4. | To understand negative resistance devices and circuits   |
| 5. | To understand time base generator circuits or sweep circuits                                   |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Understand the concept of linear wave shaping circuits                                    |
| CO2 | Understand the concept of non-linear wave shaping circuits                                |
| CO3 | Demonstrate the Bistable, Monostable and Astable Multivibrators using discrete components |
| CO4 | Evaluate the Negative Resistance circuits   |
| CO5 | Schematize voltage and current sweep circuits   |

### Syllabus

| MODULE | (NO. OF LECTURE HOURS) |
|--------|------------------------|
|        |                        |



|  |                  |
|--|------------------|
| <p><b>Module – I</b></p> <p><b>Linear Wave Shaping:</b> Introduction, Wave Shaping Circuits: High pass and low pass circuits, Response to sine, step, pulse, square, exponential and ramp inputs with different time constants, High pass as a differentiator, Low pass as an Integrator, Attenuators- response to step input, compensated attenuator, RL and RLC circuits and their response for step input, Ringing circuit.</p> | <p><b>10</b></p> |
| <p><b>Module – II</b></p> <p><b>Non-Linear Wave Shaping:</b> Diode clippers, Transistor clippers, Clipping at two independent levels, Comparators, Applications of Voltage comparators. Clamping Operation, Clamping circuit taking Source and Diode resistances into account, Clamping Circuit Theorem, Practical Clamping Circuits, Effect of Diode Characteristics on Clamping Voltage, Synchronized Clamping.</p>              | <p><b>10</b></p> |
| <p><b>Module – III</b></p> <p><b>Switching Circuits and Multivibrators:</b> Switching Circuits: Astable, Monostable and Bistable Multivibrators (both collector and emitter coupled), Schmitt trigger circuit, Symmetric and Asymmetric triggering for bistable, Schmitt trigger circuit. Multivibrators using op-amp and IC 555 timer.</p>  | <p><b>7</b></p>  |
| <p><b>Module – IV</b></p> <p><b>Negative Resistance Switching Circuits:</b> Negative resistance devices: Tunnel diode, UJT; Negative Resistance Switching Circuits: Voltage controlled and Current controlled negative resistance circuits, Negative-Resistance Characteristics, Monostable, Bistable, and Astable operations, Applications using Tunnel diode and UJT.</p>  | <p><b>7</b></p>  |
| <p><b>Module – V</b></p> <p><b>Sweep circuits:</b> General features of a Time base Signal, Methods of Generating Time Base Waveform, Miller and Bootstrap Time base Generators-Basic Principles, Transistor Miller Time Base generator, Transistor Bootstrap Time Base Generator, Transistor Current Time Base Generators, Methods of Linearity improvement.</p>   | <p><b>6</b></p>  |

**Text books:**

1. “Pulse, Digital and Switching Waveforms”, Millman and Taub, Tata McGraw-Hill
2. “Wave Generation and Shaping”, L. Strauss, TMH.
3. “Solid State Pulse Circuits”, David A. Bell, Prentice Hall India.

**Gaps in the syllabus (to meet Industry/Profession requirements):**

**POs met through Gaps in the Syllabus:**

**Topics beyond syllabus/Advanced topics/Design:**

**POs met through Topics beyond syllabus/Advanced topics/Design:**

**Course Delivery Methods**

|     |   |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors      |
| CD2 | Assignments   |
| CD3 | Laboratory experiments/teaching aids/Seminars               |
| CD4 | Industrial/guest lectures                                   |
| CD5 | Industrial visits/in-plant training                         |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation  |

**Course Outcome (CO) Attainment Assessment tools & Evaluation procedure Direct Assessment**

| Assessment Tools               | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | 50                                  |
| Semester End Examination       | 50                                  |

| Continuous Internal Assessment | % Distribution |
|--------------------------------|----------------|
| Mid semester examination       | 25             |
| Two quizzes                    | 20 (2×10)      |
| Teacher's Assessment           | 5              |

**Indirect Assessment**

1. Student Feedback on Course

### Course Delivery Methods

|     |   |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors      |
| CD2 | Assignments   |
| CD3 | Laboratory experiments/Teaching aids/Seminars               |
| CD4 | Mini Projects   |
| CD5 | Industrial visits/in-plant training                         |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation  |

### Mapping between Course Outcomes and Program Outcomes and Program Specific Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |
| CO2            | 3                      | 3 | 2 | 3 | 3 | 2 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |
| CO3            | 3                      | 3 | 2 | 3 | 3 | 2 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |
| CO4            | 3                      | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |
| CO5            | 3                      | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

### Mapping between Course Outcomes and Course Delivery Method

| Course Outcomes | Course Delivery Method  |
|-----------------|-------------------------|
| CO1             | CD1, CD2, CD3, CD6, CD7 |
| CO2             | CD1, CD2, CD3, CD6, CD7 |
| CO3             | CD1, CD2, CD3, CD6, CD7 |
| CO4             | CD1, CD2, CD3, CD6, CD7 |
| CO5             | CD1, CD2, CD3, CD6, CD7 |

### COURSE INFORMATION SHEET

**Course code: EC354**

**Course title: Pulse, Digital and Switching System Lab**

**Pre-requisite(s): Basic Electronic Engineering, Analog Circuits**

**Co- requisite(s): Pulse, Digital and Switching System**

**Credits: L: 0 T: 0 P: 3 C: 1.5 Class**

**periods per week: 03 Class: B. Tech.**

**Semester / Level: V**

**Branch: ECE Name**

**of Teacher:**

**Course Objectives**

This course enables the students to:

|    |   |
|----|---|
| 1. | Know the response of RC high pass and low pass filter circuits                |
| 2. | Realize the diode clipper and clamper circuits                                |
| 3. | Understand the operation of multivibrator circuits                            |
| 4. | Know the response of negative resistance device and design the sweep circuits |
| 5. | Understand the sweep circuits   |

**Course Outcomes**

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Analyse the RC high pass and low pass filter circuits                     |
| CO2 | Design and analyse the diode clipper and clamper circuits                 |
| CO3 | Characterize and design the multivibrator circuits                        |
| CO4 | Characterize the negative resistance device and design the sweep circuits |
| CO5 | Design of sweep circuits  |

## Syllabus

### List of Compulsory experiments:

| Experiment No. | Name of the Experiments   |
|----------------|---|
| 1              | <p>Design of a low pass RC circuit for a given cutoff frequency and obtain its frequency response and observe the response for square waveform for <math>T \ll RC</math>, <math>T = RC</math> and <math>T \gg RC</math>.</p> <p>AIM1: Obtain the frequency response of a low pass RC circuit with sine wave input.</p> <p>AIM2: Plot the output for square wave input under <math>T \ll RC</math>, <math>T = RC</math> and <math>T \gg RC</math>.</p>   |
| 2              | <p>Design of a high pass RC circuit for a given cutoff frequency and obtain its frequency response and observe the response for square waveform for <math>T \ll RC</math>, <math>T = RC</math> and <math>T \gg RC</math>.</p> <p>AIM1: Obtain the frequency response of a high pass RC circuit with sine wave input.</p> <p>AIM2: Plot the output for square wave input under <math>T \ll RC</math>, <math>T = RC</math> and <math>T \gg RC</math>.</p> |
| 3              | <p>Determination of the resonance frequency in a series RLC circuit and plotting of its waveforms.</p> <p>AIM1: Obtain the frequency response of a series RLC circuit.</p> <p>AIM2: Determine the resonance frequency in a series RLC circuit and compare this to the expected resonance value.</p>   |
| 4              | <p>Construction of Diode Clipper circuits and plotting of its waveforms.</p> <p>AIM1: Design the Shunt Positive Clipper, Shunt Negative Clipper &amp; Negative Bias series Clipper circuits and plot input-output waveforms.</p> <p>AIM2: Design the Positive bias series Clipper and Double ended shunt clipper and plot input-output waveforms.</p>   |
| 5              | <p>Construction of Diode Clamper circuits and plotting of waveforms.</p> <p>AIM1: Design the Positive Clamper &amp; Negative Clamper circuits and plot inputoutput waveforms.</p> <p>AIM2: Design the Positive Bias Clamper &amp; Negative Bias Clamper circuits and plot input-output waveforms.</p>   |
| 6              | <p>Design of Schmitt trigger circuit using transistor and generation of square wave from a given sine wave.</p>   |

|           |  |
|-----------|--|
|           | <p>AIM1: Design Schmitt Trigger circuit using BJT and plot waveforms.</p> <p>AIM2: Find the UTP, LTP and Hysteresis of the Schmitt Trigger circuit.</p>  |
| <b>7</b>  | <p>Construction of astable multivibrator using transistor and to plotting of the output waveform.</p> <p>AIM1: Observe the waveforms of Astable Multivibrator at base and collector of the transistors.</p> <p>AIM2: Verify different states and find the frequency.</p> |
| <b>8</b>  | <p>Construction of monostable multivibrator using transistor and plotting of the output waveform.</p> <p>AIM1: Observe the waveforms of Monostable Multivibrator at base and collector of the transistors.</p> <p>AIM2: Find the width of pulse.</p>                     |
| <b>9</b>  | <p>Construction of bistable multivibrator using transistor and plotting of the output waveform.</p> <p>AIM1: Observe the waveforms of Bistable Multivibrator at base and collector of the transistors.</p> <p>AIM2: Verify different states.</p>                         |
| <b>10</b> | <p>Design of Miller Sweep circuit and plotting of the output waveform.</p> <p>AIM: Design of Miller Sweep circuit and plotting of the output waveform.</p>   |
| <b>11</b> | <p>Design of Boot Strap Sweep circuit and plotting of the output waveform.</p> <p>AIM: Design of Boot Strap Sweep circuit and plotting of the output waveform.</p>   |
| <b>12</b> | <p>Construction of UJT Relaxation Oscillator and plotting of its waveforms.</p> <p>AIM: Design of UJT relaxation Oscillator with a given frequency and to observe waveforms.</p>   |

**Text books:**

1. “Pulse, Digital and Switching Waveforms”, Millman and Taub, Tata McGraw-Hill
2. “Wave Generation and Shaping”, L. Strauss, TMH.

**Gaps in the syllabus (to meet Industry/Profession requirements):****POs met through Gaps in the Syllabus:**

**Topics beyond syllabus/Advanced topics/Design:** through experiments involving design/modelling of device/circuits on advanced topics

**POs met through Topics beyond syllabus/Advanced topics/Design:** through experiments involving design/modelling of device/circuits on advanced topics

**Course Delivery Methods**

|     |   |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors      |
| CD2 | Assignments   |
| CD3 | Laboratory experiments/teaching aids/Seminars               |
| CD4 | Industrial/guest lectures                                   |
| CD5 | Industrial visits/in-plant training                         |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation  |

**Course Outcome (CO) Attainment Assessment tools & Evaluation procedure****Course Delivery Methods**

|     |  |
|-----|--|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments  |
| CD3 | Laboratory experiments/teaching aids/Seminars          |
| CD4 | Industrial/guest lectures                              |
| CD5 | Industrial visits/in-plant training                    |

|     |   |
|-----|---|
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation  |

**Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure Direct Assessment**

|                                       |  |
|---------------------------------------|--|
| <b>Assessment Tools</b>               | <b>% Contribution during CO Assessment</b> |
| <b>Continuous Internal Assessment</b> | <b>60</b>                                  |
| <b>Semester End Examination</b>       | <b>40</b>                                  |

|   |                       |
|---|-----------------------|
| <b>Continuous Internal Assessment</b>         | <b>% Distribution</b> |
| <b>Day to day performance &amp; Lab files</b> | <b>30</b>             |
| <b>Quiz(zes)</b>                              | <b>10</b>             |
| <b>Viva</b>                                   | <b>20</b>             |

|  |                       |
|--|-----------------------|
| <b>Semester End Examination</b>                  | <b>% Distribution</b> |
| <b>Examination Performance</b> <b>Experiment</b> | <b>30</b>             |
| <b>Quiz</b>                                      | <b>10</b>             |

**Indirect Assessment**

**1. Student Feedback on Course**

**Mapping between Course Outcomes and Program Outcomes and Program Specific Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| <b>CO1</b>     | 3                      | 3 | 2 | 3 | 3 | 1 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |
| <b>CO2</b>     | 3                      | 3 | 2 | 3 | 3 | 2 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |
| <b>CO3</b>     | 3                      | 3 | 2 | 3 | 3 | 2 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |
| <b>CO4</b>     | 3                      | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |
| <b>CO5</b>     | 3                      | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 3  |    | 3  | 3                                | 3  | 3  |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)



## Mapping between Course Outcomes and Course Delivery Method

| Course Outcomes | Course Delivery Method |
|-----------------|------------------------|
| CO1             | CD3, CD7               |
| CO2             | CD3, CD7               |
| CO3             | CD3, CD7               |
| CO4             | CD3, CD7               |
| CO5             | CD3, CD7               |

### COURSE INFORMATION SHEET

**Course Code: EC 355**

**Course Title:** Time Frequency and Wavelet Transform

**Pre-requisite(s):** Signals and Systems, Signal Processing Techniques, Probability and Random Processes

**Co- requisite(s):**

**Credits:** L: 3 T: 0 P: 3

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: VI**

**Branch: Electronics and Communication Engineering Name of Teacher:**

### Course Objectives

This course envisions to impart to students to:

|   |   |
|---|---|
| 1 | Understand the mathematical basis of the wavelet transform and its performance in the analysis of non-stationary signals.                         |
| 2 | Understand the concepts and properties of Continuous Wavelet Transform, MultiResolution Analysis, Discrete Wavelet Transform and Wavelet Packets. |
| 3 | Learn to implement Discrete Wavelet transform using Filter banks and Fast Lifting Scheme.   |
| 4 | Learn the time domain and frequency domain approaches for the construction of wavelets.   |
| 5 | Implement Discrete Wavelet Transform and Wavelet Packet Transform for various applications like   |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Demonstrate understanding on the wavelet transform and its performance in the analysis of non-stationary signals. |
|-----|---|

|     |   |
|-----|---|
| CO2 | Describe the concept and properties of Continuous Wavelet Transform, Multi-Resolution Analysis, Discrete Wavelet Transform and Wavelet Packets.                                       |
| CO3 | Demonstrate understanding on Discrete Wavelet transform using Filter banks and Fast Lifting Scheme. And time domain and frequency domain approaches for the construction of wavelets. |
| CO4 | Analyse the impact of Discrete Wavelet Transform and Wavelet Packet Transform for various applications like Signal compression, de-noising, detection of anomalies in ECG, EEG etc.   |
| CO5 | Apply the time frequency wavelet transform to extract the feature from real time signals  |

## SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b></p> <p>Why wavelet transform? Stationary and Non-stationary Signal, Limitations of standard Fourier analysis, Introduction to time frequency analysis, Windowed Fourier transforms (STFT), Signal representation with continuous and discrete STFT, concept of time-frequency resolution, Resolution problem associated with STFT, Heisenberg's Uncertainty principle and time frequency tiling, Stock-well transform, Wigner-Ville transform, Cohen's Class distribution.</p> | <b>8</b>               |
| <p><b>Module – II</b></p> <p>Continuous time wavelet transforms, Wavelet function and its properties, energy spectrum of wavelet, Nyquist Filters, Half band filters, Introduction, M-channel Filter banks, QMF banks, Perfect reconstruction systems, Alias free filter banks, Paraunitary perfect reconstruction Filter banks, Linear phase perfect reconstruction QMF banks.</p>   | <b>9</b>               |
| <p><b>Module – III</b></p> <p>Discrete wavelet transforms, Filter bank analysis of DWT, tiling of the timefrequency plane, dyadic grid sampling, Scaling function, Fast wavelet algorithm, compactly supported wavelets, Cascade algorithm, Franklin and spline wavelets.</p>   | <b>9</b>               |

|   |                 |
|---|-----------------|
| <p><b>Module – IV</b><br/>Wave Packet Analysis, Hilbert space frames. Frame representation. Representation of signals by frames. Iterative reconstruction. Frame algorithm. Construction of wavelets. Multiresolution analysis, Introduction to frames and biorthogonal wavelets.</p> | <p><b>8</b></p> |
| <p><b>Module – V</b><br/>Signal Analysis and synthesis, two-dimensional wavelet systems, Application of wavelet theory to signal denoising, image and video compression, multi-tone digital communication, transient detection.</p>   | <p><b>6</b></p> |

**Text Books:**

1. Y.T. Chan, Wavelet Basics, Kluwer Publishers, Boston, 1993.
2. I. Daubechies, Ten Lectures on Wavelets, Society for Industrial and Applied Mathematics, Philadelphia, PA, 1992.
3. C. K. Chui, An Introduction to Wavelets, Academic Press Inc., New York, 1992.
4. A.N. Akansu and R.A. Haddad, Multiresolution signal Decomposition: Transforms, Subbands and Wavelets, Academic Press, Oranld, Florida, 1992.

**Reference Book:**

1. Gerald Kaiser, A Friendly Guide to Wavelets, Birkhauser, New York, 1995.
2. P. P. Vaidyanathan, Multirate Systems and Filter Banks, Prentice Hall, New Jersey, 1993.
3. B.Boashash, Time-Frequency signal analysis, In S.Haykin, (editor), Advanced Spectral Analysis, pages 418--517. Prentice Hall, New Jersey, 1991.

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

**Time frequency and wavelet transform** is an advance course; hence it only lays down the foundation of pattern recognition and classification problem.

**POs met through Gaps in the Syllabus**

May be met through laboratory simulations, experiments, and design problems.

**Topics beyond syllabus/Advanced topics/Design**

Application of **Time frequency and wavelet transform** in the analysis of time varying signal. Extraction of Pattern vector from time varying signal for the development of decision support system for various applications.

**POs met through Topics beyond syllabus/Advanced topics/Design**

## Assignments & Seminars

### Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

#### Direct Assessment

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

#### Indirect Assessment

1. Students' Feedback on Course Outcome.

#### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  |                                  |    |    |
| CO2            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  |                                  |    |    |
| CO3            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 3 | 3 | 3  | 3  | 3  |                                  |    |    |
| CO4            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  |                                  |    |    |
| CO5            | 1                      | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1  |    | 1  |                                  |    |    |

#### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) **Mapping between COs and Course Delivery (CD) methods**

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD2, CD5, CD8          |

|     |   |     |                                    |
|-----|---|-----|------------------------------------|
| CD2 | Tutorials/Assignments                                       | CO2 | CD1, CD2, CD5, CD8                 |
| CD3 | Seminars  | CO3 | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD4 | Mini Projects/Projects                                      | CO4 | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD5 | Laboratory Experiments/Teaching Aids                        | CO5 | CD4, CD5, CD7, CD9                 |
| CD6 | Industrial/Guest Lectures                                   |     |                                    |
| CD7 | Industrial Visits/In-plant Training                         |     |                                    |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |     |                                    |
| CD9 | Simulation  |     |                                    |

### **COURSE INFORMATION SHEET**

**Course Code: EC 356**

**Course Title: Time Frequency and Wavelet Transform Lab.**

**Pre-requisite(s): MATLAB Co-requisite(s):**

**Credits: L: 0 T: 0 P: 3**

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: VI**

**Branch: Electronics and Communication Engineering Name of Teacher:**

#### **Course Objectives**

This course envisions to impart to students to:

|   |   |
|---|---|
| 1 | Write MATLAB code to understand the non-stationary signal.  |
| 2 | To understand behavior of real time signal in time-frequency plane.                                       |
| 3 | Illustrate the failure of FFT when time is important point find the happening of any event in the signal. |
| 4 | Elaborate the concept of STFT and wavelet transform to overcome the discrepancy of FFT.                   |

|   |   |
|---|---|
| 5 | Develop programming skills to find the engineering solution to minimize the effect of noise over observed signal. |
|---|---|

### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Model the observed sensor data using MATLAB.   |
| CO2 | Represent the signal in time-frequency plane to retrieve unique information using MATLAB.                                  |
| CO3 | De-noise the simulated data as well as observed data to get the desired information using time-frequency analysis tools.   |
| CO4 | Apply the concept of time frequency analysis to explain real life data to retrieve unique information present in the data. |
| CO5 | Visualize and solve practical pattern recognition problems.  |

### SYLLABUS

#### LIST OF EXPERIMENTS:

##### Syllabus

Lab is the application of the theory (i.e., hands-on experiments related to the course contents). Therefore, TIME FREQUENCY WAVELET TRANSFORM is the syllabus for the TIME FREQUENCY WAVELET TRANSFORM LAB. Following experiments are the guidelines for the students. However, the questions for exams are not limited to this experiment list.

##### List of experiments:

1. To generate a sine wave with a linear change in frequency. Evaluate the time-frequency characteristic using the STFT. Sine wave should vary between 10 Hz and 200 Hz over a sec period. Assume a sample rate of 500 Hz.
2. Use Stockwell Transform to analyze any simulated signal or recorded signal in time frequency plane using S-Transform.
3. To generate a sine wave with a linear change in frequency. Evaluate the time-frequency characteristic using the Wigner-Ville Distribution. Sine wave should vary between 10 Hz and 200 Hz over a sec period. Assume a sample rate of 500 Hz.

4. To generate a sine wave with a linear change in frequency. Evaluate the time-frequency characteristic using the Cohen class Distribution. Sine wave should vary between 10 and 200 Hz over a sec period. Assume a sample rate of 500 Hz.
5. Generate 2 sinusoids that change frequency in a step-like manner. Apply the Continuous Wavelet Transform and plot results using the different wavelets.
6. Plot of Wavelet boundaries for various values of scale parameter 'a'. Determine the time and scale range of various popular Wavelet function.
7. Construct a waveform of 4 sinusoids plus noise. Decompose the waveform in 4 levels, plot each level, and then reconstruct the signal.
8. Application of DWT to nonlinear filtering (Signal De-noising using Threshold). Construct a waveform of 4 sinusoids plus noise. Decompose the waveform into levels, plot each level, and then reconstruct. Evaluate the two highest resolution high pass sub-bands and zero out those samples below some threshold value.
9. Discontinuity detection. Construct a waveform of 2 sinusoids with a discontinuity in the second derivative. Decompose the waveform into 3 levels to detect the discontinuity.
10. "Balance Tree Decomposition (Wavelet Packet)". Construct a waveform of 4 sinusoids plus noise. Decompose the waveform in 3 levels, plot outputs at the terminal level.
11. Balance Tree Decomposition applied to 2 EEG signals file ecg1.mat contains two 60 sec segments of ECG data in variables ecg1 and ecg2 (fs = 250 Hz). Decompose each segment using a 3-level balanced tree composition. Take as features the RMS value of each decomposed sub-band. Find two features (RMS values) that best differentiate between the two signals and plot the features from each segment on a 2D plot. Use a Daubechies 4 or 6 -element filter. Compare the output.
12. Apply DWT for image compression and evaluate its compression ratio.

**Text Books:**

1. Y.T. Chan, Wavelet Basics, Kluwer Publishers, Boston, 1993.
2. I. Daubechies, Ten Lectures on Wavelets, Society for Industrial and Applied Mathematics, Philadelphia, PA, 1992.
3. C. K. Chui, An Introduction to Wavelets, Academic Press Inc., New York, 1992.
4. A.N. Akansu and R.A. Haddad, Multiresolution signal Decomposition: Transforms, Subbands and Wavelets, Academic Press, Oranld, Florida, 1992.

**Reference Book:**

1. Gerald Kaiser, A Friendly Guide to Wavelets, Birkhauser, New York, 1995.
2. P. P. Vaidyanathan, Multirate Systems and Filter Banks, Prentice Hall, New Jersey, 1993.
3. B.Boashash, Time-Frequency signal analysis, In S.Haykin, (editor), Advanced Spectral Analysis, pages 418--517. Prentice Hall, New Jersey, 1991.

**Gaps in the Syllabus (to meet Industry/Profession requirements) NA**

**POs met through Gaps in the Syllabus**

NA

**Topics beyond syllabus/Advanced topics/Design**

Simulations based on advanced topics after completion of compulsory twelve experiments.

**POs met through Topics beyond syllabus/Advanced topics/Design**

Assignments & Seminars

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool              | % Contribution during CO Assessment |
|------------------------------|-------------------------------------|
| Progressive Evaluation       | (60)                                |
| Attendance Marks             | 12                                  |
| Lab file Marks               | 12                                  |
| Viva Marks                   | 24                                  |
| Day-to-day performance Marks | 12                                  |
| End SEM Evaluation           | (40)                                |
| Lab quiz Marks               | 20                                  |
| Lab performance Marks        | 20                                  |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**



| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 3  | 2  | 3  |                                  |    |    |
| CO2            | 2                      | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 3  | 2  | 3  |                                  |    |    |
| CO3            | 3                      | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3  | 3  | 3  |                                  |    |    |
| CO4            | 3                      | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3  | 3  | 3  |                                  |    |    |
| CO5            | 1                      | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1  | 1  | 2  |                                  |    |    |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Mapping between COs and Course Delivery (CD) methods**

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used        |
|---------|---|----------------|------------------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD2, CD5, CD8                 |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1, CD2, CD5, CD8                 |
| CD3     | Seminars  | CO3            | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD4, CD5, CD7, CD9                 |
| CD6     | Industrial/Guest Lectures                                   |                |                                    |
| CD7     | Industrial Visits/In-plant Training                         |                |                                    |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                                    |

|     |            |  |  |
|-----|------------|--|--|
| CD9 | Simulation |  |  |
|-----|------------|--|--|

**COURSE INFORMATION SHEET**

**Course Code: EC357**

**Course Title: Adaptive Signal Processing**

**Pre-requisite(s): Digital Signal Processing**

**Co- requisite(s): Probability and Random Processes**

**Credits: L: 3 T: 0 P: 0**

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: 04**

**Branch: Electronics and Communication Engineering Name of Teacher:**

**Course Objectives**

This course envisions to impart students to:

|   |   |
|---|---|
| 1 | To understand speech production and human auditory model. To analyse structures of speech codecs and classification of speech coding techniques |
|---|---|

|   |   |
|---|---|
| 2 | To understand different speech signal processing techniques           |
| 3 | To understand basics of scalar and vector quantization                |
| 4 | To understand basic of LPC and its variants for various applications  |
| 5 | To understand different coding techniques and speech coding standards |

### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Understand the basics of production and auditory models and apply speech codecs for speech coding techniques |
| CO2 | Apply various signal processing techniques to speech signal for its enhancement                              |
| CO3 | Analyse the quality and properties of speech signal  |
| CO4 | Modify and enhance the speech and audio signals using coding techniques                                      |
| CO5 | Design and evaluate the performance of an application based speech recognition system.                       |

### SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <b>Module – I</b><br>Introduction- Speech production and modelling - Human Auditory System; General structure of speech coders; Classification of speech coding techniques – parametric, waveform and hybrid; Requirements of speech codecs –quality, coding delays, robustness. | 8                      |
| <b>Module – II</b><br>Speech Signal Processing- Pitch-period estimation, all-pole and all-zero filters, convolution; Power spectral density, periodogram, autoregressive model, autocorrelation estimation.  | 8                      |

|   |                 |
|---|-----------------|
| <p><b>Module – III</b><br/>Speech Quantization- Scalar quantization–uniform quantizer, optimum quantizer, logarithmic quantizer, adaptive quantizer, differential quantizers; Vector quantization – distortion measures, codebook design, codebook types.</p>   | <p><b>8</b></p> |
| <p><b>Module – IV</b><br/>Linear Prediction of Speech- Basic concepts of linear prediction; Linear Prediction Analysis of non-stationary signals –prediction gain, examples; Levinson-Durbin algorithm; Long term and short-term linear prediction models; Moving average prediction, Scalar Quantization of LPC- Spectral distortion measures, Quantization based on reflection coefficient and log area ratio, bit allocation; Line spectral frequency – LPC to LSF conversions, quantization based on LSF, Linear Prediction Coding- LPC model of speech production; Structures of LPC encoders and decoders; Voicing detection; Limitations of the LPC model.</p> | <p><b>8</b></p> |
| <p><b>Module – V</b><br/>Code Excited Linear Prediction-CELP speech production model; Analysisby-synthesis; Generic CELP encoders and decoders; Excitation codebook search – state-save method, zero-input zero-state method; CELP based on adaptive codebook, Adaptive Codebook search; Low Delay CELP and algebraic CELP, Speech Coding Standards-An overview of ITU-T G.726, G.728 and G.729standards.</p>   | <p><b>8</b></p> |

**Text Books:**

1. L.R. Rabiner, B. H. Juang and B. Yegnanarayana, “Fundamentals of Speech Recognition”, Pearson, Education 2011
2. A. M. Kondoz, “Digital Speech”, Second Edition (Wiley Students Edition), 2004.
3. W. C. Chu, “Speech Coding Algorithms: Foundation and Evolution of Standardized Coders”, Wiley Inter science, 2003.

**Reference Books: NA**

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

25. Applications of speech signal processing techniques through hardware platform.

**POs met through Gaps in the Syllabus**

NA

**Topics beyond syllabus/Advanced topics/Design**

Teaching through Research paper

**POs met through Topics beyond syllabus/Advanced topics/Design**

2

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| <b>Assessment Tool</b>   | <b>% Contribution during CO Assessment</b> |
|--------------------------|--|
| First Quiz               | 10   |
| Mid Semester Examination | 25   |
| Second Quiz              | 10   |
| Teacher's Assessment     | 5  |
| End Semester Examination | 50   |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| <b>Course Outcome</b> | <b>Program Outcomes (POs)</b> |          |          |          |          |          |          |          |          |           |           |           | <b>Program Specific Outcomes (PSOs)</b> |           |           |
|-----------------------|-------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|---|-----------|-----------|
|                       | <b>1</b>                      | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>6</b> | <b>7</b> | <b>8</b> | <b>9</b> | <b>10</b> | <b>11</b> | <b>12</b> | <b>13</b>                               | <b>14</b> | <b>15</b> |
| <b>CO1</b>            | 3                             | 3        | 2        | 2        | 2        | 1        | 1        |          |          | 2         | 3         | 3         | 1                                       | 2         | 2         |
| <b>CO2</b>            | 3                             | 3        | 3        | 3        | 3        | 2        | 2        |          |          | 2         | 3         | 3         | 1                                       | 2         | 3         |
| <b>CO3</b>            | 3                             | 3        | 3        | 3        | 3        | 1        | 2        |          | 2        | 3         | 3         | 3         | 2                                       | 3         | 3         |
| <b>CO4</b>            | 3                             | 3        | 2        | 3        | 3        | 2        | 2        | 1        | 2        | 3         | 3         | 3         | 2                                       | 2         | 3         |
| <b>CO5</b>            | 3                             | 2        | 1        | 1        | 2        | 1        | 1        |          | 1        | 1         | 1         | 2         | 3                                       | 3         | 3         |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD2, CD 8              |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1 and CD9                 |
| CD3     | Seminars  | CO3            | CD1, CD2 and CD3            |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1 and CD2                 |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD1, CD2, CD9               |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9     | Simulation  |                |                             |

## COURSE INFORMATION SHEET

Course code: **EC359**

Course title: **Microcontrollers and Interfacing**

Pre-requisite(s): Microprocessors Applications Co-requisite(s):

Credits: L: 3 T: 1 P:

Class schedule per week: 3x

Class: B. Tech

Semester / Level: VI/3

Branch: ECE Name

of Teacher:

### Course Objectives

This course enables the students:

|    |  |
|----|--|
| 1. | Explain the concept of microcontrollers and embedded system architecture.              |
| 2. | Develop assembly language programming skill in the student for 8051 microcontroller.   |
| 3. | Explain the interrupt and serial I/O features of 8051 microcontroller                  |
| 4. | To outline the importance of different peripheral devices & their interfacing to 8051. |
| 5. | Introduce embedded microcontrollers and their programming                              |

### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Demonstrate the knowledge about microcontrollers and embedded systems architecture.  |
| CO2 | Write 8051 based assembly language program for given problem.  |
| CO3 | Will be able to interface 8051 with peripheral devices.  |
| CO4 | Will be able to communicate 8051 with peripheral devices using serial and parallel I/O and design and implement microcontroller based system for given application |
| CO5 | Schematize the microcontroller based real time systems.  |

### SYLLABUS

| MODULE | (NO. OF LECTURE HOURS) |
|--------|------------------------|
|        |                        |

|  |           |
|--|-----------|
| <p><b>Module – I</b><br/>Introduction to Microcontrollers, Microprocessors vs Microcontrollers, History and Applications of Microcontrollers, 8051 Architecture, Introduction, Features, Pin details, Internal Memory organization, General purpose RAM, Bit addressable RAM, Register banks, Special function Registers.</p>  | <b>10</b> |
| <p><b>Module – II</b><br/>8051 Addressing Modes, Boolean Processor, External Memory Addressing, Interrupt Structure and priorities, 8051 Instruction types like Data movement, Logic, Arithmetic, Control transfer and Program Control Instructions, Instruction Set in detail. 8051 Programming examples like Arithmetic and Logic operation, Branching, Looping, Stack Operations, Subroutines, Parameter passing, A few Industrial examples, Software and Hardware Development tools, Environments, Assembly Language, Interpreters, Debugging hints.</p> | <b>10</b> |
| <p><b>Module – III</b><br/>8051 Interrupts and Timers/counters: Basics of interrupts, 8051 interrupt structure, Timers and Counters, 8051 timers/counters, programming 8051 timers in assembly and C. 8051 Serial Communication, connections to RS-232, Serial communication Programming in assembly and C.</p>  | <b>7</b>  |
| <p><b>Module – IV</b><br/>Basics of I/O concepts, I/O Port Operation, Interfacing 8051 to LCD, Keyboard, I/O devices interfacing with 8051 using 8255A, parallel and serial ADC, DAC, Stepper motor interfacing and DC motor interfacing and programming.</p>  | <b>8</b>  |
| <p><b>Module – V</b><br/>Introduction to Embedded Microcontrollers, 68 HC11 and 68 HC12 Microcontrollers, Software and Hardware development, I/O Resources, CPU12 Programming model, Basic Assembly Programming techniques, Introduction to Real time I/O and Multitasking.</p>  | <b>5</b>  |

**Text books:**

1. Mohamed Ali Mazidi, Janice Gillispie Mazidi, “The 8051 microcontroller and embedded systems”, Pearson education, 2004
2. “Programming and Customising the 8051 Microcontroller”, by Myke Predko

**Reference books:**

1. “Advanced Microprocessor and Microcontrollers”, by S.K. Venkata Ram.

Gaps in the syllabus (to meet Industry/Professional requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**



## Direct Assessment

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

## Indirect Assessment

1. Students' Feedback on Course Outcome.

## Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 3 | 2 | 2 | 2 | 2 |   | 1 | 1  |    | 1  | 2                                | 2  | 1  |
| CO2            | 3                      | 3 | 2 | 3 | 2 | 1 | 1 |   | 1 | 1  |    | 1  | 2                                | 2  | 1  |
| CO3            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 |   | 1 | 1  |    | 1  | 2                                | 2  | 1  |
| CO4            | 3                      | 3 | 3 | 2 | 2 | 2 | 2 |   | 1 | 1  |    | 1  | 2                                | 2  | 1  |
| CO5            | 3                      | 3 | 2 | 3 | 2 | 1 | 1 |   | 1 | 1  |    | 1  | 2                                | 2  | 1  |

Correlation Levels 1, 2 or 3 as defined below:

- 1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

## Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1,CD5,CD 8                |

|     |   |     |              |
|-----|---|-----|--------------|
| CD2 | Tutorials/Assignments                                       | CO2 | CD1,CD5,CD 8 |
| CD3 | Seminars  | CO3 | CD1,CD5,CD 8 |
| CD4 | Mini Projects/Projects                                      | CO4 | CD1,CD5,CD 8 |
| CD5 | Laboratory Experiments/Teaching Aids                        | CO5 | CD1,CD5,CD 8 |
| CD6 | Industrial/Guest Lectures                                   |     |              |
| CD7 | Industrial Visits/In-plant Training                         |     |              |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |     |              |
| CD9 | Simulation  |     |              |

### COURSE INFORMATION SHEET

Course code: **EC360**

Course title: **Microcontroller Lab** Pre-requisite(s):

Co- requisite(s):

Credits: L: 3 T: 0 P: 0

Class schedule per week: 03 Class:

B. Tech.

Semester / Level: 03

Branch: ECE

Name of Teacher:

## Course Objectives

This course enables the students:

|   |   |
|---|---|
| 1 | To introduce the basics of microcontroller and its applications                         |
| 2 | To develop the assembly language programming skills in the student for microcontrollers |
| 3 | To expertise working with Keil compiler and embedded C programming                      |
| 4 | To give practical training for interfacing I/O devices with 8051                        |
| 5 | To discuss the real time applications of microprocessor and microcontrollers            |

## Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Demonstrate the working of microcontroller and its programming           |
| CO2 | Write 8081 based assembly language program.                              |
| CO3 | Interface the I/O devices with and 8051                                  |
| CO4 | Design circuits for various real time applications with microcontrollers |
| CO5 | Able to work with Keil compiler and embedded C programming               |

## Syllabus

Lab is the application of the theory (i.e., hands-on experiments related to the course contents). Therefore, EC359 Microcontrollers and Interfacing is the syllabus for the EC360 Microcontroller Lab. Following experiments are the guidelines for the students. However, the questions for exams are not limited to this experiment list.

### List of Compulsory experiments:

## 8051 PROGRAMMING

1. DATA TRANSFER OPERATIONS (BLOCK MOVE/ SORTING)
2. ARITHMETIC OPERATIONS (ADD, SUB, DIV)
3. BOOLEAN ARITHMETIC AND LOGICAL OPERATION (SET, RESET, MOVE)
4. CODE CONVERSION (ASCII TO HEX, HEX TO ASCII, BINARY TO BCD)
5. DELAY SUBROUTINES USING DIFFERENT REGISTER BANKS
6. TIMERS OPERATION IN DIFFERENT MODES
7. COUNTER OPERATIONS
8. SERIAL I/O PROGRAMMING AT DIFFERENT BAUD RATE
9. INTERRUPT SERVICE ROUTINES

## INTERFACING

1. LCD PANNEL AND HEX KEYBOARD INTERFACE
2. ADC INTERFACING FOR INPUTTING SENSOR DATA
3. DAC INTERFACING FOR WAVEFORM GENERATION
4. STEPPER MOTOR CONTROL
5. DC MOTOR CONTROL

### Text Book:

1. Mohamed Ali Mazidi, Janice Gillispie Mazidi, "The 8051 microcontroller and embedded systems", Pearson education, 2004

### Reference Book:

Gaps in the syllabus (to meet Industry/Profession requirements): N/A

POs met through Gaps in the Syllabus: N/A

Topics beyond syllabus/Advanced topics/Design:N/A

POs met through Topics beyond syllabus/Advanced topics/Design: N/A

## Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

### Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|-----------------|-------------------------------------|
|-----------------|-------------------------------------|

|                                |             |
|--------------------------------|-------------|
| Continuous Internal Assessment | (60)        |
| Attendance Marks               | 10          |
| Lab file Marks                 | 06          |
| Day-to-day performance Marks   | 44          |
| <b>End SEM Evaluation</b>      | <b>(40)</b> |
| Lab quiz Marks                 | 08          |
| Lab Viva marks                 | 12          |
| Lab performance Marks          | 20          |

### Indirect Assessment

1. Student Feedback on Course

**Gaps in the syllabus (to meet Industry/Profession requirements): N/A**

**POs met through Gaps in the Syllabus: N/A**

**Topics beyond syllabus/Advanced topics/Design:**

**POs met through Topics beyond syllabus/Advanced topics/Design:**

### Course Outcome (CO) Attainment Assessment tools & Evaluation procedure Direct Assessment

| Assessment Tool               | % Contribution during CO Assessment |
|-------------------------------|-------------------------------------|
| <b>Progressive Evaluation</b> | <b>(60)</b>                         |
| Attendance Marks              | 10                                  |
| Lab file Marks                | 06                                  |
| Day-to-day performance Marks  | 44                                  |
| <b>End SEM Evaluation</b>     | <b>(40)</b>                         |
| Lab quiz Marks                | 08                                  |
| Lab Viva marks                | 12                                  |
| Lab performance Marks         | 20                                  |

### **Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| <b>CO1</b>     | 3                      | 3 | 2 | 3 | 3 | 1 | 1 |   |   | 2  |    | 2  | 2                                | 2  | 1  |

|            |   |   |   |   |   |   |   |  |  |   |  |   |   |   |   |
|------------|---|---|---|---|---|---|---|--|--|---|--|---|---|---|---|
| <b>CO2</b> | 3 | 3 | 2 | 3 | 3 | 3 | 2 |  |  | 2 |  | 2 | 2 | 2 | 1 |
| <b>CO3</b> | 3 | 3 | 2 | 3 | 3 | 3 | 2 |  |  | 2 |  | 2 | 2 | 2 | 1 |
| <b>CO4</b> | 3 | 3 | 2 | 3 | 3 | 2 | 2 |  |  | 2 |  | 2 | 2 | 2 | 1 |
| <b>CO5</b> | 3 | 3 | 2 | 3 | 3 | 2 | 2 |  |  | 2 |  | 2 | 2 | 2 | 1 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

| <b>Mapping Between COs and Course Delivery (CD) methods</b> |   |                       |                               |
|---|---|-----------------------|-------------------------------|
| <b>CD</b>   | <b>Course Delivery methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method</b> |
| CD1   | Lecture by use of boards/LCD projectors/OHP projectors      | CO1                   | CD5, CD9                      |
| CD2   | Tutorials/Assignments/Quiz (s)                              | CO2                   | CD5, CD9                      |
| CD3   | Seminars  | CO3                   | CD5, CD9                      |
| CD4   | Mini projects/Projects                                      | CO4                   | CD5, CD9                      |
| CD5   | Laboratory experiments/teaching aids                        | CO5                   | CD5, CD9                      |
| CD6   | Industrial/guest lectures                                   |                       |                               |
| CD7   | Industrial visits/in-plant training                         |                       |                               |
| CD8   | Self- learning such as use of NPTEL materials and internets |                       |                               |
| CD9   | Simulation  |                       |                               |

## **COURSE INFORMATION SHEET**

**Course code: EC361**

**Course title: Digital Systems Design with FPGAs**

**Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering, EC201**

**Electronic Devices Co- requisite(s):**

**Credits:** L: 3 T: 0 P: 0 C: 3

**Class schedule per week:** 03 **Class:**

**B. Tech.**

**Semester / Level:** VI/03

**Branch:** ECE

**Name of Teacher:**

### Course Objectives

This course enables the students to:

|    |  |
|----|--|
| 1. | Understand Implementation strategies for digital ICs.                          |
| 2. | Interpret timing Issues in digital circuits and apply the perceived knowledge. |
| 3. | Appraise and analyse the arithmetic building blocks.                           |
| 4. | Design and Evaluate the characteristics of memory and array structures.        |
| 5. | Validate and test manufactured circuits.                                       |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Describe and illustrate with diagram the Implementation strategies for digital ICs.   |
| CO2 | Sketch and explain timing Issues in digital circuits.   |
| CO3 | Diagram and explain the arithmetic building blocks, illustrate their characteristics and analyse them.  |
| CO4 | Design and schematize the memory cell and array structures, assess their characteristics and summarize their features.  |
| CO5 | Schematize and write the principles of manufactured circuit test techniques. Integrate the techniques with circuit to be tested, validate and test the circuit. |

### SYLLABUS

| MODULE | (NO. OF LECTURE HOURS) |
|--------|------------------------|
|--------|------------------------|

|  |                 |
|--|-----------------|
| <p><b>Module – I</b><br/> <b>Implementation strategies for digital ICs:</b> From Custom to Semicustom and Structured Array Design Approaches, Custom Circuit Design, Cell-Based Design Methodology, Array-Based Implementation Approaches: Pre-diffused (or MaskProgrammable) Arrays, Pre-wired Arrays: The write-once or fuse-based FPGA, The non-volatile FPGA, The volatile or RAM-Based FPGA, Implementation Platforms of the Future.</p>  | <p><b>8</b></p> |
| <p><b>Module – II</b><br/> <b>Timing Issues in digital circuits:</b>Timing Classification of Digital Systems, Synchronous Design: Synchronous Timing Basics, Sources of Skew and Jitter, Clock-Distribution Techniques; Self-Timed Circuit Design: Self-Timed Adder Circuit, Completion-Signal Generation with an example of DCVSL, Self-Timed Signaling with an example of Muller C-element, Practical Examples of Self-Timed Logic such as Self-resetting 3-input OR; Synchronizers and Arbiters: Static Timing Analysis (STA), Design examples of clock and test bench using Verilog/SystemVerilog HDL.</p> | <p><b>8</b></p> |
| <p><b>Module – III</b><br/> <b>Designing arithmetic building blocks:</b> Full Adder Circuit Design Considerations, <b>Multiplier</b> Design Considerations; <b>Power and Speed Tradeoff's in Datapath Structures:</b> Design Time Power-Reduction Techniques, RunTime Power Management, Reducing the Power in Standby (or Sleep) Mode, <b>Design examples</b> of Datapath using Verilog/ SystemVerilog HDL.</p>  | <p><b>8</b></p> |
| <p><b>Module – IV</b><br/> <b>Designing memory and array structures:</b> Memory classification, Memory Architectures and Building Blocks; The Memory Core: Read-Only Memories, Flash Memory, Static Random Access Memory (SRAM), Memory Peripheral Circuitry: The Address Decoders, Sense Amplifiers, Voltage References, Drivers/Buffers.</p>   | <p><b>8</b></p> |
| <p><b>Module – V</b><br/> <b>Validation and test of manufactured circuits:</b> Boundary-Scan Design, Built-in Self-Test (BIST), Test-Pattern Generation, Fault Models: Stuck-At Faults, ShortCircuit and Open-Circuit Faults, Fault Coverage, Delay Fault Testing, Automatic Test-Pattern Generation (ATPG), FPGA-assisted testing.</p>  | <p><b>8</b></p> |

**Textbooks:**

1. J. Rabaey, A. Chandrakasan, B. Nikolic, “Digital Integrated Circuits: A Design Perspective”, 2nd Edition, Prentice Hall, 2003.
2. Neil H. E. Weste and David Money Harris, CMOS VLSI Design – A Circuits and Systems Perspective, Addison Wesley, 4/e, 2011.



**Reference books:**

1. Samir Palnitkar, Verilog HDL: A guide to Digital Design and Synthesis, SunSoft Press, 1996.
2. Stuart Sutherland, Simon Davidmann, Peter Flake, SystemVerilog Design - A Guide to Using SystemVerilog for Hardware Design and Modeling, 2/e, Springer, 2006.

**Gaps in the syllabus (to meet Industry/Profession requirements):**

1. Hands-on-practical for CMOS IC (Integrated Circuit) fabrication.

**POs met through Gaps in the Syllabus:**

10

**Topics beyond syllabus/Advanced topics/Design:**

1. Analog and RF circuits.

**POs met through Topics beyond syllabus/Advanced topics/Design: 10****Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure****Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) | Program Specific Outcomes (PSOs) |
|----------------|------------------------|----------------------------------|
|                |                        |                                  |

|            | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|
| <b>CO1</b> | 3 | 3 | 2 | 3 | 3 | 1 | 1 |   |   | 1  |    | 1  | 3  | 2  | 1  |
| <b>CO2</b> | 3 | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 1  |    | 1  | 3  | 2  | 1  |
| <b>CO3</b> | 3 | 3 | 2 | 3 | 3 | 2 | 2 |   |   | 1  |    | 2  | 3  | 2  | 1  |
| <b>CO4</b> | 3 | 3 | 2 | 3 | 3 | 2 | 1 |   |   | 1  |    | 2  | 3  | 2  | 1  |
| <b>CO5</b> | 3 | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 1  |    | 2  | 3  | 2  | 1  |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD7, CD 8                     |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1 and CD9                        |
| CD3            | Seminars  | CO3                   | CD1, CD2 and CD3                   |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1 and CD2                        |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1 and CD2                        |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

## **COURSE INFORMATION SHEET**

**Course code: EC362**

**Course title: Digital Systems Design with FPGAs Lab**

**Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering, EC201 Electronic Devices**

**Co- requisite(s): EC361 Digital Systems Design with FPGAs**

**Credits:** L: 0 T: 0 P: 3 C: 1.5

**Class schedule per week: 03 Class:**

B. Tech.

**Semester / Level: VI/03**

**Branch: ECE Name  
of Teacher:**

**Course Objectives**

**Course Objectives**

This course enables the students to:

|    |  |
|----|--|
| A. | Understand the modelling styles of HDLs such as VHDL, Verilog and SystemVerilog for designing/developing digital circuits.       |
| B. | Apply their understanding to design/develop given digital circuits using various modelling styles of VHDL/Verilog/SystemVerilog. |
| C. | Analyse and explain the outputs displayed on the prototyping board.  |
| D. | Appraise the simulated/compiled/synthesized/downloaded CPLD/FPGA designs and evaluate the results.                               |
| E. | Develop CPLD/FPGA designs and create necessary configuration bitstream files and download them on the prototyping kit.           |

**Course Outcomes**

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Outline models of digital circuits and translate the same into VHDL/Verilog/SystemVerilog program. Simulate, compile, synthesize, and download CPLD designs onto the prototyping kit and demonstrate/show the results displayed on the kit and explain the same. |
| CO2 | Write VHDL/Verilog/SystemVerilog model and develop given digital circuits. Simulate and synthesize the CPLD design. Use Spartan-2 CPLD Trainer Kit and download the design onto it. Demonstrate and interpret the results displayed on the kit.                  |
| CO3 | Outline VHDL/Verilog/SystemVerilog model and given design digital circuits. Simulate and compile/synthesize the CPLD design, download the same onto the prototyping kit (Spartan-2 CPLD Trainer Kit). Test and analyse the outputs displayed on the kit          |

|     |  |
|-----|--|
| CO4 | Write VHDL/Verilog/SystemVerilog model of given digital circuit. Simulate and compile/synthesize the FPGA design and find errors, if any. Create the FPGA configuration bitstream file, download the same onto the prototyping kit (Spartan-3E FPGA Starter Kit) and test its operation and evaluate outputs displayed on the kit. |
| CO5 | Develop VHDL/Verilog/SystemVerilog model and design given digital circuits. Simulate and compile/synthesize the FPGA design, create the FPGA configuration bitstream file, download the same onto the prototyping kit (Spartan-3E FPGA Starter Kit), test and validate its operation.  |

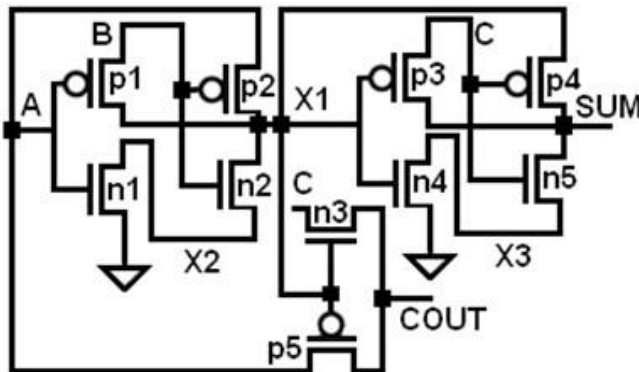
## **SYLLABUS**

Lab is the application of the theory (i.e., hands-on experiments related to the course contents). Therefore, **EC361 Digital Systems Design with FPGAs** is the syllabus for the **EC362 Digital**

**Systems Design with FPGAs Lab.** Following experiments are the guidelines for the students. However, the questions for exams are not limited to this experiment list.

**List of Compulsory experiments:**

5. Outline a model of clock generator and test bench for simulating a digital circuit and translate the same into VHDL/Verilog/SystemVerilog RTL codes. Simulate and synthesize the CPLD design using the Xilinx development software (**Xilinx ISE 8.1i.**) and find errors, if any. Create the CPLD configuration bitstream file (\*.jed), use **Spartan-2 CPLD Trainer Kit** and download CPLD design (using the iMPACT programming software and the JTAG cable) onto it, demonstrate/show the results displayed on the kit and explain the same.
6. Write VHDL/Verilog/SystemVerilog RTL codes and develop a sign-magnitude adder. Simulate and synthesize the CPLD design using the Xilinx development software (**Xilinx ISE 8.1i.**) and find errors, if any. Create the CPLD configuration bitstream file (\*.jed), use **Spartan-2 CPLD Trainer Kit** and download CPLD design (using the iMPACT programming software and the JTAG cable) onto it. Observe/examine the results for their correctness.
7. Outline a switch-level Verilog/SystemVerilog model and write RTL codes for the circuit shown below. Experiment with the prototyping kit (**Spartan-3E FPGA Starter Kit**), test and analyse its operation.



8. Outline a VHDL/Verilog/SystemVerilog model and design a stopwatch. Simulate and compile/synthesize the FPGA design using the Xilinx development software (**Xilinx ISE 14.1i.**) and find errors, if any. Create the FPGA configuration bitstream file (\*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan-3E FPGA Starter Kit**), test and evaluate its operation.
9. Develop a VHDL/Verilog/SystemVerilog model and design a digital multiplier. Simulate and compile/synthesize the FPGA design using the Xilinx development software, create the FPGA configuration bitstream file (\*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan-3E FPGA Starter Kit**), test and validate its operation.
10. Develop a VHDL/Verilog/SystemVerilog model and design a traffic signal controller. Simulate and compile/synthesize the FPGA design using the Xilinx development software, create the FPGA configuration bitstream file (\*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan3E FPGA Starter Kit**), test and validate its operation.
11. Design 2-input XOR gate using complex gate and use the same to design a 1-bit full adder within the given specification to achieve propagation delay ( $t_p$ ) of OUTPUT CARRY no longer

than 100 ns and average power consumption ( $P_{avg}$ ) not higher than 100  $\mu$ W. Simulate the designs, test and validate your anticipation using Cadence EDA tool. Load the input and output of the designed full adder with inverters to obtain realistic input and output. Simulate and report the propagation delay ( $t_p$ ) and power consumption ( $P_{avg}$ ) of your design.

12. Develop a 4-bit full adder utilizing the previously designed 1-bit full adder within the given specification to achieve propagation delay ( $t_p$ ) of the FINAL CARRY no longer than 1  $\mu$ s and average power consumption ( $P_{avg}$ ) not higher than 1 mW. Simulate the designs using Cadence EDA tool, test and validate your anticipation. Load the input and output of the designed full adder with 1-bit full adder to obtain realistic input and output. Simulate and report the propagation delay ( $t_p$ ) and power consumption ( $P_{avg}$ ) of your design.
13. Design a positive-edge-triggered D flip-flop with setup time and hold time no longer than 10 ns and 15 ns respectively. Simulate using Cadence EDA tool and find errors, if any. Test its functionality, tabulate the obtained results for setup time and hold time and compare the same with the given specifications.
14. Develop a 4-bit register based on the previously designed positive-edge-triggered D flip-flop. Simulate using Cadence EDA tool and find errors, if any. Test its functionality.
15. Design a JK flip-flop with setup time and hold time no longer than 20 ns and 25 ns respectively. Simulate using Cadence EDA tool and find errors, if any. Test its functionality, tabulate the obtained results for setup time and hold time and compare the same with the given specifications.
16. Develop a 4-bit presettable counter based on the previously designed a JK flip-flop. Simulate using Cadence EDA tool and find errors, if any. Test its functionality.

#### **List of optional experiments:**

17. Develop a VHDL/Verilog/SystemVerilog model and design a floating-point adder. Simulate and compile/synthesize the FPGA design using the Xilinx development software, create the FPGA configuration bitstream file (\*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan-3E FPGA Starter Kit**), test and validate its operation.
18. Develop a VHDL/Verilog/SystemVerilog model and design a FIFO buffer. Simulate and compile/synthesize the FPGA design using the Xilinx development software, create the FPGA configuration bitstream file (\*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan-3E FPGA Starter Kit**), test and validate its operation.
19. Develop a VHDL/Verilog/SystemVerilog model and design a divider. Simulate and compile/synthesize the FPGA design using the Xilinx development software, create the FPGA configuration bitstream file (\*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan-3E FPGA Starter Kit**), test and validate its operation.
20. Develop a VHDL/Verilog/SystemVerilog model and design a BINARY-TO-BCD conversion circuit. Simulate and compile/synthesize the FPGA design using the Xilinx development software, create the FPGA configuration bitstream file (\*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan3E FPGA Starter Kit**), test and validate its operation.

21. Write a VHDL/Verilog/SystemVerilog model and develop a 1:4-bit demultiplexer. Simulate and synthesize the CPLD design using the Xilinx development software (**Xilinx ISE 8.1i.**) and find errors, if any. Create the CPLD configuration bitstream file (\*.jed), use **Spartan-2 CPLD Trainer Kit** and download CPLD design (using the iMPACT programming software and the JTAG cable) onto it, demonstrate and interpret the results displayed on the kit.
22. Write a VHDL/Verilog/SystemVerilog model and develop a 4-bit magnitude comparator. Simulate and synthesize the CPLD design using the Xilinx development software (**Xilinx ISE 8.1i.**) and find errors, if any. Create the CPLD configuration bitstream file (\*.jed), use **Spartan-2 CPLD Trainer Kit** and download CPLD design (using the iMPACT programming software and the JTAG cable) onto it, demonstrate and interpret the results displayed on the kit.
23. Outline a VHDL/Verilog/SystemVerilog model and design a seven-segment display decoder. Simulate and compile/synthesize the CPLD design using the Xilinx development software (**Xilinx ISE 8.1i.**) and find errors, if any. Create the CPLD configuration bitstream file (\*.jed), download CPLD design (using the iMPACT programming software and the JTAG cable) onto the prototyping kit (use **Spartan-2 CPLD Trainer Kit**), test and analyse the outputs displayed on the kit.
24. Develop a VHDL/Verilog/SystemVerilog model and design a simple processor that performs basic operations such as ADD, SUM, MUL and DIV using 8-bit operands. Simulate and compile/synthesize the FPGA design using the Xilinx development software, create the FPGA configuration bitstream file (\*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan-3E FPGA Starter Kit**), test and validate its operation.
25. Outline a VHDL/Verilog/SystemVerilog model and design a 16:4-bit encoder. Synthesize the circuit, download the configuration bitstream file onto the prototyping kit (use **Spartan-2 CPLD Trainer Kit**) and verify its operation. Simulate and compile/synthesize the CPLD design using the Xilinx development software (**Xilinx ISE 8.1i.**) and find errors, if any. Create the CPLD configuration bitstream file (\*.jed), download CPLD design (using the iMPACT programming software and the JTAG cable) onto the prototyping kit (use **Spartan-2 CPLD Trainer Kit**), test and analyse outputs displayed on the kit.
26. Outline a VHDL/Verilog/SystemVerilog model and design a modulo-N binary up-counter with synchronous Clear control signal. Simulate and compile/synthesize the CPLD design using the Xilinx development software (**Xilinx ISE 8.1i.**) and find errors, if any. Create the CPLD configuration bitstream file (\*.jed), download CPLD design (using the iMPACT programming software and the JTAG cable) onto the prototyping kit (use **Spartan-2 CPLD Trainer Kit**), test and analyse outputs displayed on the kit.
27. Write a VHDL/Verilog/SystemVerilog model of 2-by-2 register. Simulate and compile/synthesize the FPGA design using the Xilinx development software (**Xilinx ISE 14.1i.**) and find errors, if any. Create the FPGA configuration bitstream file (\*.bit), download FPGA design (using the iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan-3E FPGA Starter Kit**) and test its operation and evaluate output displayed on the kit.
28. Write an 8x8 RAM VHDL/Verilog/SystemVerilog model. Simulate and compile/synthesize the FPGA design using the Xilinx development software (**Xilinx ISE 14.1i.**) and find errors, if any. Create the FPGA configuration bitstream file (\*.bit), download FPGA design (using the

iMPACT programming software and the USB cable) onto the prototyping kit (use **Spartan3E FPGA Starter Kit**) and test its operation and evaluate output displayed on the kit.

**Textbooks:**

1. J. Rabaey, A. Chandrakasan, B. Nikolic, “Digital Integrated Circuits: A Design Perspective”, 2nd ed., Prentice Hall, 2003.
2. Neil H. E. Weste, David Money Harris, “CMOS VLSI Design – A Circuits and Systems Perspective,” 4<sup>th</sup> ed., Addison Wesley, 2011.
3. Neil H. E. Weste, David Money Harris, “CMOS VLSI Design – A Circuits and Systems Perspective,” 3<sup>rd</sup> ed., Pearson Education, 2006.

**Reference books:**

1. Samir Palnitkar, “Verilog HDL: A guide to Digital Design and Synthesis,” SunSoft Press, 1996.
2. Stuart Sutherland, Simon Davidmann, Peter Flake, “SystemVerilog Design - A Guide to Using SystemVerilog for Hardware Design and Modeling,” 2<sup>nd</sup> ed., Springer, 2006.

**Gaps in the syllabus (to meet Industry/Profession requirements):**

1. Hands-on-practical for CMOS digital IC (Integrated Circuit) fabrication.

**POs met through Gaps in the Syllabus:**

10

**Topics beyond syllabus/Advanced topics/Design:**

1. Mixed-signal circuit design.

**POs met through Topics beyond syllabus/Advanced topics/Design:**

10

**Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure**

**Direct Assessment**

| <b>Assessment Tools</b>        | <b>% Contribution during CO Assessment</b> |
|--------------------------------|--|
| Continuous Internal Assessment | 60   |
| Semester End Examination       | 40   |



| <b>Continuous Internal Assessment</b> | <b>% Distribution</b> |
|---------------------------------------|-----------------------|
| Day to day performance & Lab files    | 30                    |
| Quiz(zes)                             | 10                    |
| Viva                                  | 20                    |

| <b>Semester End Examination</b>    | <b>% Distribution</b> |
|------------------------------------|-----------------------|
| Examination Experiment Performance | 30                    |
| Quiz                               | 10                    |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

#### Course Delivery Methods

|     |   |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors      |
| CD2 | Assignments   |
| CD3 | Laboratory experiments/Teaching aids/Seminars               |
| CD4 | Mini Projects   |
| CD5 | Industrial visits/in-plant training                         |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation  |

#### Mapping between Course Outcomes and Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| <b>CO1</b>     | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 3                                | 3  | 1  |
| <b>CO2</b>     | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 3                                | 3  | 2  |
| <b>CO3</b>     | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 3                                | 3  | 2  |
| <b>CO4</b>     | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 3                                | 3  | 2  |
| <b>CO5</b>     | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 |   | 3  |    | 3  | 3                                | 3  | 1  |

#### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

#### Mapping Between COs and Course Delivery (CD) methods

| <b>Course Outcomes</b> | <b>Course Delivery Method</b> |
|------------------------|-------------------------------|
| CO1                    | CD1, CD3, CD6, CD7            |
| CO2                    | CD1, CD3, CD6, CD7            |
| CO3                    | CD1, CD3, CD6, CD7            |
| CO4                    | CD1, CD3, CD6, CD7            |
| CO5                    | CD1, CD3, CD6, CD7            |

### **COURSE INFORMATION SHEET**

**Course code: EC363**

**Course title: Nanoelectronics**

**Pre-requisite(s): EC101 Basics of Electronics and Communication Engineering, EC201 Electronic Devices Co- requisite(s):**

**Credits: L: 3 T: 0 P: 0 C: 3**

**Class schedule per week: 03 Class: B.**

Tech.

**Semester / Level: VI/03**

**Branch: ECE Name**

**of Teacher:**

### Course Objectives

This course enables the students to:

|   |  |
|---|--|
| 1 | Understand the theory of Classical Particles, Classical Waves, Quantum Particles, Quantum Mechanics of Electrons, Free and Confined electrons. |
| 2 | Interpret the various aspects of Electrons Subject to a Periodic Potential – Band Theory of Solids and apply the perceived knowledge.          |
| 3 | Appraise and analyse the characteristics of the theory of Coulomb Blockade and the Single-Electron Transistor.                                 |
| 4 | Perceive models of Semiconductor Quantum Wells, Quantum Wires and Quantum Dots and evaluate their characteristics.                             |
| 5 | Apprehend Nanowires, Ballistic Transport and Spin Transport models and develop/integrate them for their applications.                          |

### Course Outcomes

After the completion of this course, a student will be able to:

|     |  |
|-----|--|
| CO1 | Describe and illustrate the theory of Classical Particles, Classical Waves, Quantum Particles, Quantum Mechanics of Electrons, Free and Confined electrons.  |
| CO2 | Sketch and explain various aspects of Electrons Subject to a Periodic Potential – Band Theory of Solids.   |
| CO3 | Illustrate with the sketch of theory of Coulomb Blockade and the Single-Electron Transistor, diagram their characteristics and analyse them.   |
| CO4 | Appraise the models of Semiconductor Quantum Wells, Quantum Wires and Quantum Dots, schematize their characteristics, assess and summarize their features.   |
| CO5 | Schematize the structure of Nanowires, and design Field Effect Transistors that have carrier with Ballistic Transport and Spin Transport. Schematize their characteristics and prepare an inference. |

### SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <p><b>Module – I</b><br/> <b>Classical Particles, Classical Waves, Quantum Particles, Quantum Mechanics of Electrons, Free and Confined electrons:</b><br/>           Introduction to nanoelectronics, Origins of Quantum Mechanics, Light as Wave, Light as a Particle, Electrons as Particles, Electrons as Waves, Wave packets and Uncertainty, General Postulates of Quantum Mechanics, Time-Independent Schrodinger’s Equation, Free Electrons, Free Electron Gas theory of Metals, Electrons Confined to a Bounded Region of Space and Quantum Numbers, Quantum Dots, Wires and Wells.</p> | <b>8</b>               |
| <p><b>Module – II</b><br/> <b>Electrons Subject to a Periodic Potential – Band Theory of Solids:</b><br/>           Crystalline Materials, Electrons in a Periodic Potential, Kronig-Penney Model of Band Structure, Band theory of Solids, Graphene and Carbon Nanotubes, Tunneling Through a potential Barrier, Potential Energy Profiles for Material Interfaces, Applications of Tunnelling.</p>   | <b>8</b>               |
| <p><b>Module – III</b><br/> <b>Coulomb Blockade and the Single-Electron Transistor:</b><br/>           Coulomb Blockade, The Single-Electron Transistor, Single Electron Transistor logic; Other SET and FET Structures: Carbon Nanotube Transistors (FETs and SETs), Semiconductor Nanowire FETs and SETs, Molecular SETs and Molecular Electronics; Density of States, Classical and Quantum Statistics.</p>   | <b>8</b>               |
| <p><b>Module – IV</b><br/> <b>Models of Semiconductor Quantum Wells, Quantum Wires and Quantum Dots:</b><br/>           Semiconductor Heterostructures and Quantum Wells, Quantum Wires and Nanowires; Quantum Dots and Nanoparticles, Fabrication Techniques for Nanostructures: Lithography, Nanoimprint Lithography, Split-Gate Technology, Self-Assembly.</p>  | <b>8</b>               |
| <p><b>Module – V</b><br/> <b>Nanowires, Ballistic Transport and Spin Transport:</b><br/>           Classical and Semiclassical Transport, Ballistic Transport, Carbon Nanotubes and Nanowires, Transport of Spin, and Spintronics: The Transport of Spin, Spintronic Devices and Applications.</p>   | <b>8</b>               |

**Textbooks:**

1. George W. Hanson, Fundamentals of Nanoelectronics, Pearson, 2009.
2. W. Ranier, Nanoelectronics and Information Technology (Advanced Electronic Material and Novel Devices), Wiley-VCH, 2003.
3. K.E. Drexler, Nanosystems, Wiley, 1992.

**Reference books:**

1. John H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge University Press, 1998.
2. Charles P. Poole, F. J. Owens, Introduction to Nanotechnology, Wiley, 2003.

**Gaps in the syllabus (to meet Industry/Profession requirements):**

1. Hands-on-practical for Device fabrication.

**POs met through Gaps in the Syllabus:**

10

**Topics beyond syllabus/Advanced topics/Design:**

1. TFET
2. MTJ
3. Memristor
4. RTD.

**POs met through Topics beyond syllabus/Advanced topics/Design:**

10

**Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

## Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 1 | 3 | 3 | 1 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO2            | 3                      | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO3            | 3                      | 3 | 1 | 3 | 3 | 3 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO4            | 3                      | 3 | 1 | 3 | 3 | 1 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO5            | 3                      | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD7, CD 8              |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1 and CD9                 |
| CD3     | Seminars  | CO3            | CD1, CD2 and CD3            |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1 and CD2                 |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD1 and CD2                 |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9     | Simulation  |                |                             |

## COURSE INFORMATION SHEET

**Course Code: EC365**

**Course Title: Radar and Navigation Systems Pre-requisite(s): Microwave Theory and Techniques Co-requisite(s):**

**Credits: L: 3 T: 0 P: 0 C:3**

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: Sixth/Third**

**Branch: Electronics & Communication Engineering Name of Teacher:**

### **Course Objectives**

This course envisions to impart to students to:

|   |  |
|---|--|
| 1 | To appraise an overview of Radar Systems and Radar Equation.           |
| 2 | To perceive the CW, FM, MTI and Pulse Doppler Radar                    |
| 3 | To grasp the detection of radar signals in noise                       |
| 4 | To understand the navigation, radio direction finding and radio ranges |
| 5 | To understand the different types of navigation systems and landing    |

### **Course Outcomes**

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Able to explain Radar Systems and Radar Equation.                                       |
| CO2 | Able to demonstrate CW, FM, MTI and Pulse Doppler Radar                                 |
| CO3 | Able to explain the detection of radar signals in noise                                 |
| CO4 | Able to demonstrate the concept of navigation, radio direction finding and radio ranges |
| CO5 | Able to demonstrate the concept of navigation systems and landing                       |

**SYLLABUS**



| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b><br/> <b>Introduction to Radar System and Radar Equation:</b> Introduction, History and Applications of Radar, Radar Block Diagram and Operation, Radar Frequencies, Prediction of Range Performance, Minimum Detectable Signal, Receiver Noise, Probability density Functions, Signal-to-noise Ratio, Integration of Radar Pulses, Radar Cross Section of Targets, Cross-section Fluctuations, Transmitter Power, Pulse Repetition Frequency and Range Ambiguities, Antenna parameters, System Losses, Propagation Effects</p> | <p><b>10</b></p>       |
| <p><b>Module – II</b><br/> <b>CW, FM, MTI and Pulse Doppler Radar:</b> The Doppler Effect, CW Radar, Frequency-Modulated CW Radar, Airborne Doppler Navigation, Multiple CW radar, Delay line Cancellers, Multiple or Staggered Pulse Repetition Frequencies, Range gated Doppler Filters, Block Diagram of Digital Signal Processor, Example of MTI radar Processor, Pulse Doppler Radar, Non coherent MTI, MTI from moving platform, Other types of MTI, Airborne Radar</p>   | <p><b>10</b></p>       |
| <p><b>Module – III</b><br/> <b>Detection of Radar Signals in Noise:</b> Introduction, Matched-Filter Receiver, Correlation Detector, Detection Criteria, Detector Characteristics, Performance of the Radar Operator, Automatic Detection, Constant-False-Alarm-Rate (CFAR) Receiver</p>  | <p><b>7</b></p>        |
| <p><b>Module – IV</b><br/> <b>Introduction to Navigation, RDF and Radio Ranges:</b> Introduction to Navigation, Methods of Navigation, Loop Antenna, Loop input circuits, aural null direction finder, Goniometer, Errors in Direction Finding, Adcock Direction Finder, Direction finding at very high frequency, Automatic Direction Finder, Range and accuracy of direction finder, LF/MF Four course Radio Range, VHF Omni Directional Range, and VOR receiving Equipment, Range and Accuracy of VOR</p>  | <p><b>7</b></p>        |
| <p><b>Module – V</b><br/> <b>Convolutional Codes Navigation Systems and Landing:</b> LORAN, DECCA navigation system, Instrument Landing System, Ground controlled Approach System, Microwave landing system, Distance Measuring Equipment, operation of DM ACAS, Doppler navigation-Doppler Effect, Doppler frequency equations, Trilateration Doppler Spectrum, GPS principle of operation, Position location determination, principle of GPS receiver and applications, Differential GPS, Navstar</p>   | <p><b>6</b></p>        |

GPS.

**Text Books:**

1. M.I. Skolnik, "Introduction to Radar System", McGraw Hill 2<sup>nd</sup> Edition.
2. N. S. Nagaraja "Elements of Electronic Navigation, 2<sup>nd</sup> edition, Tata McGraw-Hill Education

**Reference Books:**

1. Radar Systems and Radio Aids to Navigation, Sen & Bhattacharya, Khanna publishers
2. Radar Principles", Peyton Z. Peebles ,JohnWiley, 2004
3. J.C Toomay, " Principles of Radar", 2nd Edition –PHI, 2004
4. Radar Systems Analysis and Design Using MATLAB, Bassem R. Mahafza., CHAPMAN & HALL/CRC
5. Radar Engg. Hand Book M.I. Skolnik, Publisher: McGraw Hill
6. Roger J Suullivan, "Radar Foundations for Imaging and Advanced Topics".
7. Global Navigation Satellite Systems Insights into GPS, GLONASS, Galileo, Compass, and others B. Bhatta BSP Books
8. K. K. Sharma " Fundamentals of Radar, Sonar and Navigation Engineering" 4<sup>th</sup> Edition Katson Books

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

**POs met through Gaps in the Syllabus:** PO10 will be met though report-writing/presentationbased assignment

**Topics beyond syllabus/Advanced topics/Design**

**POs met through Topics beyond syllabus/Advanced topics/Design: PO1**

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher’s Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students’ Feedback on Course Outcome.

## Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 3  | 1  | 3  | 3                                | 2  | 1  |
| CO2            | 3                      | 3 | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 3  | 1  | 3  | 3                                | 2  | 2  |
| CO3            | 3                      | 3 | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 3  | 1  | 3  | 3                                | 2  | 1  |
| CO4            | 3                      | 3 | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 3  | 1  | 3  | 3                                | 2  | 3  |
| CO5            | 3                      | 3 | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 3  | 1  | 2  | 3                                | 2  | 2  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High) **Mapping Between COs and Course Delivery (CD) methods**

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD8                    |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1 ,CD8                    |
| CD3     | Seminars  | CO3            | CD1, CD8                    |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1, CD8                    |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD1,CD8                     |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9     | Simulation  |                |                             |

**Course code: EC366**

**Course title: Advanced Microwave Engineering Lab**

**Pre-requisite(s): Electromagnetic Fields and Waves Microwave Theory and Techniques Co-requisite(s):**

**Credits: L: 0 T: 0 P: 3 C: 1.5**

**Class schedule per week: 03 Class: B.**

**Tech.**

**Semester / Level: Sixth/Three**

**Branch: Electronics & Communication Engineering**

**Name of Teacher: ALL**

**Course Objectives:**

This course enables the students:

|     |   |
|-----|---|
| 16. | To develop an understanding about the propagation of modes in free space and waveguides.  |
| 17. | To develop an understanding about the RF behavior of passive components, matching network and microstrip resonators.                |
| 18. | To develop an ability to understand about the waveguide coupler, bandpass filter and propagation characteristics in ferrite medium. |
| 19. | To develop an ability to understand about microwave transistor amplifier and microstrip transmission line.                          |
| 20. | To develop an ability to understand a microstrip reconfigurable bandpass filter and monopole microstrip antenna                     |

**Course Outcomes:**

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Demonstrate understanding of the propagation of modes in free space and waveguides.                             |
| CO2 | Demonstrate understanding of the RF behavior of passive components, matching network and microstrip resonators. |
| CO3 | Design a waveguide coupler, bandpass filter and understanding of propagation characteristics in ferrite medium. |
| CO4 | Design a microwave transistor amplifier and microstrip transmission line.                                       |
| CO5 | Design a reconfigurable bandpass filter and monopole microstrip antenna   |

## Syllabus

### List of Compulsory experiments:

**7. Name of the Experiment: Propagation mode in free space**

AIM-1: Analysis of various propagation mode in free space.

**8. Name of the Experiment: Propagation modes in waveguide**

AIM-1: Analysis of propagation modes in waveguide.

**9. Name of the Experiment: RF behavior of passive components**

AIM-1: Using MATLAB, obtain the RF behavior of passive components (Resistor, Capacitor and Inductor)

**5. Name of the Experiment: Matching network**

AIM-1: Using MATLAB, design an L-section matching network to match a series RC with given load and line impedance at a frequency.

**12. Name of the Experiment: Microstrip resonator**

AIM-1: Consider a microstrip resonator constructed from a length of  $50 \Omega$  open circuited

microstrip line. For a given substrate, using MATLAB, at a given resonance frequency, compute the required length of line, propagation constant, attenuation due to conductor loss and dielectric loss and unloaded “Q” of resonator

**13. Name of the Experiment: Waveguide coupler**

AIM 1: Using MATLAB, obtain coupling and directivity versus frequency plot for the four hole Chebyshev waveguide coupler for X band

**14. Name of the Experiment: Bandpass filter**

AIM 1: Using MATLAB, Design a third order bandpass filter having a 0.5 dB equal-ripple response for the required center frequency, bandwidth and the impedance.

**15. Name of the Experiment:, Propagation in ferrite medium**

AIM 1: Using MATLAB, plot and analyze the phase and attenuation constant verses frequency curve for RHCP and LHCP plane propagation in ferrite medium

**16. Name of the Experiment: RF transistor amplifier**

Using MATLAB, Obtain and plot the stability regions of a given transistor amplifier parameters on Smith Chart. If amplifier is unstable then suggest the method to stabilize it.

**17. Name of the Experiment:, Microstrip transmission line**

AIM 1: Using IE3D/HFSS, design a 50 ohm microstrip transmission line for 90 degree phase shift. Calculate the required dimensions of microstrip using MATLAB.

**18. Name of the Experiment:, Reconfigurable bandpass filter**

AIM 1: Using IE3D/HFSS, Design a reconfigurable bandpass filter for WIMAX and WLAN applications

**19. Name of the Experiment:, Monopole microstrip antenna**

AIM 1: Using IE3D/HFSS, Design a CPW fed monopole microstrip antenna on a given substrate

Text Book:

- 1.“David M. Pozar, "Microwave Engineering", Third Edition, Wiley India.
- 2.R. Ludwig and G. Bogdanov, “RF Circuit Design, Theory and Applications”, Pearson, 2<sup>nd</sup> Edition.

Reference Books:

- 1.S. Y. Liao , “Microwave Devices & Circuits”, PHI 2<sup>nd</sup> Edition
- 2.B. R. Vishvakarma, R U Khan, M K. Meshram, “ Intoduction to Microwave Measurements”
- 3.R.E.Collin, "Foundations for Microwave Engineering", Second edition, IEEE Press.

**Gaps in the syllabus (to meet Industry/Profession requirements): NA**

**POs met through Gaps in the Syllabus: N/A.**

**Topics beyond syllabus/Advanced topics/Design: N/A**

**POs met through Topics beyond syllabus/Advanced topics/Design: N/A**

## Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

### Direct Assessment

| Assessment Tool               | % Contribution during CO Assessment |
|-------------------------------|-------------------------------------|
| <b>Progressive Evaluation</b> | <b>(60)</b>                         |
| Attendance Marks              | <b>12</b>                           |
| Day-to-day performance Marks  | <b>06</b>                           |
| Lab Viva marks                | <b>20</b>                           |
| Lab file Marks                | <b>12</b>                           |
| Lab Quiz-I Marks              | <b>10</b>                           |
| <b>End SEM Evaluation</b>     | <b>(40)</b>                         |
| Lab Quiz-II Marks             | <b>10</b>                           |
| Lab performance Marks         | <b>30</b>                           |

### **Indirect Assessment –**

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

### **Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |   |   |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|---|---|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1                                | 2 | 3 |
| <b>CO1</b>     | 3                      | 3 | 2 | 2 | 3 | 1 | - | - | 1 | 3  | 1  | 2  | 2                                | 2 | 1 |
| <b>CO2</b>     | 3                      | 3 | 2 | 2 | 3 | 1 | - | - | 1 | 3  | 1  | 2  | 2                                | 2 | 1 |
| <b>CO3</b>     | 3                      | 3 | 3 | 3 | 3 | 1 | - | - | 1 | 3  | 1  | 3  | 2                                | 2 | 1 |
| <b>CO4</b>     | 3                      | 3 | 3 | 3 | 3 | 1 | - | - | 1 | 3  | 1  | 3  | 2                                | 2 | 1 |
| <b>CO5</b>     | 3                      | 3 | 3 | 3 | 3 | 1 | - | - | 1 | 3  | 1  | 3  | 2                                | 2 | 1 |

### **Correlation Levels 1, 2 or 3 as defined below:**

- 1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods:**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD5 ,CD8                      |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1, CD5,CD8, CD9                  |
| CD3            | Seminars/ Quiz (s)  | CO3                   | CD1, CD5,CD8, CD9                  |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1, CD5, CD8, CD9                 |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1, CD5, CD8, CD9                 |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |



## COURSE INFORMATION SHEET

**Course Code: EC 367**

**Course Title: Computer Networking**

**Pre-requisite(s): Fundamentals of Data Communication Co-requisite(s):**

**Credits:** L: 3 T: 1 P: 0

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: Sixth**

**Branch: Electronics & Communication Engineering Name of Teacher:**

### Course Objectives

This course envisions to impart to students to:

|    |   |
|----|---|
| 1. | Understand the different network topologies, transmission media and different MAC sub-layers used in the design of a Local Area Network (LAN) and Wireless LAN's. |
| 2. | Familiarize the layer of operation and working of different intermediate devices, network layer protocols and internet addressing mechanism.                      |
| 3. | Familiarize with the transport layer protocols to be used as an end-to-end service provider.  |
| 4. | Illustrate different encryption and message authentication schemes to provide security at different layers.   |
| 5. | To outline the functioning of the Application layer and different protocols of application layers e.g. HTTP, SMTP, WWW, FTP, VOIP etc.                            |

### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Recall the basic reference model of LAN, their topologies and different types of intermediate systems in a network used. |
| CO2 | Understand the basics of various internet protocols and their functioning.   |
| CO3 | Understand the basics of various internet and transport protocols and their functioning.                                 |
| CO4 | Explain the significance of network security in a public network like internet.  |

## SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b></p> <p><b>Local Area Network:</b> Local Area Networks: Background, Topologies and Transmission Media, LAN standards IEEE 802 reference Model, Logical Link Control.</p> <p><b>Medium Access Control:</b> Medium Access Control, IEEE 802.3 Medium Access Control, Ethernet, Fast Ethernet, Gigabit Ethernet, Token Ring and FDDI, IEEE 802.5 Transmission Medium Options.</p> <p><b>Connecting devices and Backbone Networks:</b> Bridges, Functions of a Bridge, Bridge Protocol Architecture, Fixed routing, Spanning tree approach, Connecting devices like Repeaters, Hubs, Bridges ,Two-layer switches, Routers and Three layer switches, Backbone Networks, Bus Backbone, Star Backbone, Connecting remote LANs.</p> | <b>11</b>              |
| <p><b>Module – II</b></p> <p><b>Internetworking Operations:</b> Principles of Internetworking, Requirements, Architectural approaches, Connectionless Internetworking, Addressing, Routing techniques, Static versus Dynamic Routing,</p> <p><b>Internet Protocols:</b> IPv4, Internet Control Message Protocol (ICMP), IPV6 Structure, Header, CIDR Addressing, ICMPV6.</p> <p><b>Internet work Operations:</b> Unicast and Multicast routing, Autonomous Systems, Unicast routing protocol OSPF, Internet Group Management Protocol (IGMP), Border Gateway Protocol, Integrated Service Architecture, ISA Approach, Components, Services, Queuing Discipline, Resource Reservation Protocol (RSVP), Differentiated Services (DS).</p>         | <b>10</b>              |
| <p><b>Module – III</b></p> <p><b>Transport layer operations:</b> Connection Oriented Transport Protocol Mechanisms, Reliable Sequencing networks services, Unreliable network services, TCP Services, TCP Header Format, TCP Mechanisms, TCP Implementation policy options, TCP Congestion Control, Retransmission Timer Management, Window Management, Quality of Service, User datagram Protocol (UDP).</p>   | <b>7</b>               |

|  |          |
|--|----------|
| <b>Module – IV</b><br>Network Security : Passive and Active Attacks, Symmetric Encryption, Encryption Algorithms, Key Distribution, Traffic Padding, Message Authentication, Hash function, Secure Hash function, Public-key Encryption, Digital Signature, RSA Public Key Encryption algorithm, Key Management,   | <b>7</b> |
| Secure Socket layer and Transport layer Security, SSL Architecture, SSL Record Protocol, Change Cipher Spec Protocol, Alert Protocol, Handshake Protocol, IP level security IPSEC, Application layer security PGP, Firewall, Virtual Private Networks.   |          |
| <b>Module – V</b><br><b>Application Layer Protocols:</b> Distributed Applications: Electronic Mail, Simple Mail Transfer Protocol (SMTP), Multipurpose Internal Mail Extension (MIME), Client Server Model, Socket Interface, Simple Network Management Protocol (SNMP) SNMP V2 and SNMP V3, Hypertext Transfer Protocol (HTTP) Overview Message Entities, World Wide Web (WWW), HTML, Common Gateway Interface (CGI), Voice over IP (VOIP). | <b>5</b> |

**Text Books:**

1. Data and Computer Communication, 7/e. by William Stallings.
2. Data Communication and Networking, 3/e. by Behrouz. A. Forouzan.

**Reference Books:**

1. The Internet and its protocols: A comparative approach. by Adrian Farrel.
2. Computer Networks 4/e by Andrew S. Tanenbaum.

**Gaps in the Syllabus (to meet Industry/Profession requirements):**

1. Simulation of different types of networks and their performance comparison.

**POs met through Gaps in the Syllabus**

3, 4 and 12

**Topics beyond syllabus/Advanced topics/Design**

1. Hardware implementation of MAC protocols.
2. Hardware implementation of Bridges and Routers.
3. Setting up of a practical internet network.

**POs met through Topics beyond syllabus/Advanced topics/Design**

2, 3, 4, 12

## Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

### Direct Assessment

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 1 | 1 | 2 | 1 | - | - | - | - | -  | -  | 2  | 2                                | 1  | 3  |
| CO2            | 3                      | 3 | 3 | 2 | 1 | - | - | - | - | -  | -  | 1  | 3                                | 1  | 3  |
| CO3            | 3                      | 3 | 2 | 2 | 2 | - | - | - | - | -  | -  | 1  | 2                                | 2  | 2  |
| CO4            | 3                      | 2 | 1 | 1 | 1 | - | - | - | - | -  | -  | 1  | 2                                | 2  | 2  |
| CO5            | 3                      | 1 | 1 | 2 | 1 | - | - | - | - | -  | -  | 2  | 2                                | 1  | 3  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1                         |
| CD2     | Tutorials/Assignments                   | CO2            | CD1                         |

|     |   |     |             |
|-----|---|-----|-------------|
| CD3 | Seminars  | CO3 | CD1 CD2     |
| CD4 | Mini Projects/Projects                                      | CO4 | CD1 and CD2 |
| CD5 | Laboratory Experiments/Teaching Aids                        | CO5 | CD1 and CD2 |
| CD6 | Industrial/Guest Lectures                                   |     |             |
| CD7 | Industrial Visits/In-plant Training                         |     |             |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |     |             |
| CD9 | Simulation  |     |             |

**COURSE INFORMATION SHEET**

**Course Code: EC369**

**Course Title: Wireless Networks**

**Pre-requisite(s): Basic Sciences Co-requisite(s):**

**Credits:** L: 3 T: 1 P: 0 C:3

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: Sixth/Three**

**Branch: Electronics & Communication Engineering Name of Teacher:**

**Course Objectives**

This course envisions to impart to students to:

|     |  |
|-----|--|
| 16. | Explain basics of wireless networks system   |
| 17. | Explain network protocols used for WPAN, WLAN and WWAN.  |
| 18. | Explain Transmission control protocol  |
| 19. | Explain IPv4 and IPV6 addressing system  |
| 20. | An ability to explain the functioning, protocols, capabilities and application of various wireless communication networks. |

**Course Outcomes**

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Demonstrate an understanding on basics of Wireless network system |
|-----|---|

|     |   |
|-----|---|
| CO2 | Demonstrate an ability to identify the protocol for network environment based on geographical condition, dimension and resource condition |
| CO3 | Demonstrate an understanding on IP addressing protocol  |
| CO4 | Demonstrate an understanding on basics of Wireless network system   |
| CO5 | Explain the functioning, protocols, capabilities and application of various wireless communication networks.                              |

## SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <b>Module – I</b><br>Ad-hoc wireless networks : MANET and WSN, security in wireless networks, energy constrained networks, adhoc versus Infrastructure based wireless networks  | <b>9</b>               |
| <b>Module – II</b><br>Wireless personal area networks (bluetooth, network connection establishment in bluetooth, bluetooth protocol stack, bluetooth link type, bluetooth security. ZigBee: components & network Topologies. ultra wideband communication                                 | <b>9</b>               |
| <b>Module – III</b><br>Wireless local area and metropolitan area networks: WLAN Technology, network architecture, protocol architecture, physical layer, data link layer, medium access methods, security in 802.11 systems, WLAN standards. Wireless metropolitan area networks (WiMAX). | <b>8</b>               |

|  |          |
|--|----------|
| <b>Module – IV</b><br><br>Wireless wide area networks: GSM, GPRS, 3G wireless systems, evolution of cdma2000, differences between cdma2000 & WCDMA. HSPA and LTE.  | <b>8</b> |
| <b>Module – V</b><br><br>Wireless network protocols: mobile network layer protocol (mobile IP, Ipv4 vs. IPv6, IPv6, IPv6 transition mechanism, dynamic host configuration protocol), mobile transport layer protocol (traditional TCP, classical TCP improvements), agent discovery, agent advertisement, registration, authentication, route optimisation, mobility support for IPV6. | <b>7</b> |

**Text Books:**

1. J. Schiller, “Mobile Communication” 2/e, Pearson Education, 2012.
2. Vijay K Garg, “Wireless Communications and Networks”, Morgan Kaufmann Publishers an Imprint of Elsevier, USA 2009 (Indian reprint) **Reference**

**Books:**

1. Behrouz A. Forouzan, “Data Communications and Networking”, McGraw-Hill, 2007
2. Sanjay Kumar, “Wireless Communication the Fundamental and Advanced Concepts” River Publishers, Denmark, 2015 (Indian reprint).

**Gaps in the Syllabus (to meet Industry/Profession requirements) : Nil**

**POs met through Gaps in the Syllabus : NA**

**Topics beyond syllabus/Advanced topics/Design**

**POs met through Topics beyond syllabus/Advanced topics/Design**

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |

|                          |    |
|--------------------------|----|
| Teacher's Assessment     | 5  |
| End Semester Examination | 50 |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |   |   |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|---|---|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1                                | 2 | 3 |
| CO1            | 3                      | 2 | 2 | 1 | - | - | - | - | - | -  | -  | 2  | 3                                | 2 | 1 |
| CO2            | 3                      | 3 | 3 | 3 | 2 | - | - | - | - | -  | -  | 1  | 3                                | 2 | 1 |
| CO3            | 3                      | 3 | 3 | 3 | 2 | - | - | - | - | -  | -  | 1  | 3                                | 2 | 1 |
| CO4            | 3                      | 3 | 3 | 3 | 3 | - | - | - | - | -  | -  | 1  | 3                                | 2 | 2 |
| CO5            | 3                      | 3 | 3 | 3 | 2 | - | - | - | - | -  | -  | 2  | 3                                | 2 | 2 |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods



| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD 8                          |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1, CD 8 and CD9                  |
| CD3            | Seminars  | CO3                   | CD1, CD 8 and CD9                  |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1 and CD 8                       |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1 and CD 8                       |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

### **COURSE INFORMATION SHEET**

**Course code: EC370**

**Course title: Wireless Networking Lab**

**Pre-requisite(s):** Fundamental Knowledge of Communication System, basic understanding of communication process and communication media **Co- requisite(s):**

**Credits:** L: 0 T: 0 P: 3 C: 1.5

**Class schedule per week: 03 Class: B.**

**Tech.**

**Semester / Level: Sixth/Three**

**Branch: Electronics & Communication Engineering**

**Name of Teacher: ALL**

**Course Objectives:**

This course enables the students:

|   |  |
|---|--|
| 1 | To develop an ability to design various kind of wired/wireless networks using network simulator. |
| 2 | To evaluate and compare the performance of several network protocols (AODV, DYMO etc).           |
| 3 | To design and interpret wireless sensor networks and standards                                   |
| 4 | To design and examine the hardware setup for wireless Wide Area network                          |
| 5 | To design and examine the hardware setup for wireless sensor network                             |

## Course Outcomes:

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Have an ability to design and evaluate various kind of wired/wireless networks.  |
| CO2 | Be able to analyze and compare the performance of various routing protocols (like AODV, DYMO etc) for wireless adhoc network as well as for infrastructure based wireless network.                           |
| CO3 | Have an ability to design and interpret wireless networks and standards (WLAN, Bluetooth etc) through simulation software as well as evaluate the impact of various system parameters on wireless standards. |
| CO4 | Have an ability to design and analyze the hardware setup for wireless Wide Area network  |
| CO5 | Have an ability to design and analyze the hardware setup for   |

## Syllabus

### List of Compulsory experiments:

#### 1. Name of the Experiment: Set up link to analyze flow of operation (packets)

AIM-1: Study and demonstrate the flow of operation (packets) in QualNet Network Simulator GUI.

#### 2. Name of the Experiment: Set up link to analyze Ad hoc mode scenario

AIM-1: Design and evaluate an Ad hoc mode scenario using QualNet Network Simulator.

#### 3. Name of the Experiment: Set up link to analyze infrastructure mode scenario

AIM-1: To configure and evaluate an infrastructure mode scenario using QualNet Simulator GUI.

#### 4. Name of the Experiment: Set up link to measure effect of mobility in an Ad hoc mode scenario

AIM-1: Configure and estimate the effect of mobility to the data transferred in an Ad hoc mode scenario.

#### 5. Name of the Experiment: : Set up link to measure effect of mobility in an infrastructure mode scenario

AIM-1: Configure and estimate the effect of mobility to the data transferred in an infrastructure mode.

**6.Name of the Experiment: Compare AODV and DYMO**

AIM-1: Compare two routing protocols (AODV and DYMO) in ad hoc mode scenario.

**7.Name of the Experiment: Configure VOIP Application Layer Protocol**

AIM-1: **Configure** VOIP Application layer protocol based on H.323 in an infrastructure.

**8.Name of the Experiment: *Evaluate performance of Multicasting Application***

AIM-1: Configure and evaluate a multicasting application in a wired/wireless scenario.

**9.Name of the Experiment: *GSM Setup***

AIM-1: Assembly of GSM set up and real time study of GSM 07.05 and 07.07 AT commands (such as network registration call control call setting etc at least 10 command).

**10.Name of the Experiment: Wireless Sensor Network**

AIM 1: To Interface analog sensor with Scientech 2311 Wireless sensor network.

**11.Name of the Experiment: Temperature and Light Sensor**

AIM 1:To develop a code to read temperature and light sensor data from sensor module attached to the radio module using SENSnuts GUI platform

**12.Name of the Experiment: Level Based Routing**

AIM 1:To create a LBR (level based routing) based multi-hop network using SENSnuts GUI platform.

**Text Book:**

1. Vijay K. Garg, “Wireless Communications and Networks”, Morgan Kaufmann Publishers an Imprint of Elsevier, USA 2009 (Indian reprint).

**Reference Books:**

1. Theodore S Rappaport, “Wireless Communication: Principles and Practice” Prentice Hall of India, New Delhi, 2006, 2/e.
2. Lab. Manuals concerning each experiment.

**Gaps in the syllabus (to meet Industry/Profession requirements): NA**

**POs met through Gaps in the Syllabus: N/A.**

**Topics beyond syllabus/Advanced topics/Design: N/A**

**POs met through Topics beyond syllabus/Advanced topics/Design: N/A**

**Course Outcome (CO) Attainment Assessment tools & Evaluation procedure**

**Direct Assessment**

| <b>Assessment Tool</b>        | <b>% Contribution during CO Assessment</b> |
|-------------------------------|--|
| <b>Progressive Evaluation</b> | <b>(60)</b>                                |
| Attendance Marks              | <b>12</b>                                  |
| Day-to-day performance Marks  | <b>06</b>                                  |
| Lab Viva marks                | <b>20</b>                                  |
| Lab file Marks                | <b>12</b>                                  |
| Lab Quiz-I Marks              | <b>10</b>                                  |
| <b>End SEM Evaluation</b>     | <b>(40)</b>                                |
| Lab Quiz-II Marks             | <b>10</b>                                  |
| Lab performance Marks         | <b>30</b>                                  |

**Indirect Assessment –**

1. Student Feedback on Course Outcome

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |   |   |   |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|---|---|---|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1                                | 2 | 3 |   |
| CO1            | 3                      | 3 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 2  | 2  | 2  | 2                                | 2 | 2 | 1 |
| CO2            | 3                      | 3 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 2  | 2  | 2  | 2                                | 2 | 2 | 1 |
| CO3            | 3                      | 2 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 2  | 2  | 2  | 2                                | 2 | 2 | 1 |
| CO4            | 3                      | 3 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 2  | 2  | 2  | 2                                | 2 | 2 | 1 |
| CO5            | 3                      | 2 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 2  | 2  | 2  | 2                                | 2 | 2 | 1 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods:**

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD5, CD9               |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1, CD5, CD9               |
| CD3     | Seminars/ Quiz (s)  | CO3            | CD1, CD5, CD9               |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1, CD5                    |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD1, CD5                    |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9     | Simulation  |                |                             |

### **COURSE INFORMATION SHEET**

**Course Code: EC 371**

**Course Title: Introduction to Electromagnetic Compatibility**

**Pre-requisite(s): Electromagnetic Field and Waves Co-requisite(s):**

**Credits: L: 3 T: 0 P: 0**

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level:**

**Branch: Electronics and Communication Engineering Name of Teacher:**

#### **Course Objectives**

This course envisions to impart to students to:

|   |  |
|---|--|
| 1 | Explain requirement of EMI & EMC concept and impart knowledge on different units and standards used for Electromagnetic compatibility in electronic/electric system. |
| 2 | Develop an ability to analyze, measure and evaluate the radiated and conducted emissions to examine the compatibility.   |
| 3 | Develop an ability to analyze and evaluate the impact of EMI mitigation techniques such as shielding and grounding.  |

|   |   |
|---|---|
| 4 | Develop an ability to explain the impact of EMI on system design.   |
| 5 | Review and present the literature ethically and also develop the skill to work individually or in a team. |

### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Explain the requirement of EMI & EMC concept and impart knowledge on different units and standards used for Electromagnetic compatibility in electronic/electric system. |
| CO2 | Analyze, measure and evaluate radiated and conducted emissions to examine the electromagnetic compatibility.   |
| CO3 | Analyze and evaluate the impact of EMI mitigation techniques such as shielding and grounding.  |
| CO4 | Explain the impact of EMI on system design.  |
| CO5 | Review and write the literature related to EMI & EMC to report it ethically.   |

## SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b><br/> <b>Introduction:</b> A brief history of EMI/EMC, Analysis of EMI, Type of Noise and Interference, Electromagnetic Compatibility, Radiated Emission and susceptibility, Conducted Emission and Susceptibility, Benefits of good EMC Design, Brief description of EMC regulations, Examples of EMC related problems. EMC requirements for Electronic Systems: Government regulations, Requirement for Commercial products and Military products, Radiated Emission limits for Class A, Class B, FCC and CISPR, measurement of Emissions for verification of compliance: Radiated Emission and Conducted Emissions, Typical product emissions, Additional product requirements, design constraints for products, Advantages of EMC Design.</p> | <p><b>8</b></p>        |
| <p><b>Module – II</b><br/> <b>Conducted Emission and Susceptibility:</b> Measurement of Conducted emission: LISN, Common and Differential mode currents, Power supply filters: Basic properties of filters, A generic power supply filter topology, Effect of filter elements on common and differential mode currents, Separation of conducted emissions into common and differential mode components for diagnostic purpose, Power supplies: Linear and SMPS, Effect of Power Supply Components on Conducted emissions, Power Supply and Filter placement, Conducted Susceptibility.</p>  | <p><b>9</b></p>        |
| <p><b>Module – III</b><br/> <b>Radiated Emission and Susceptibility:</b> Simple Emission models for wires and PCB lands: Differential mode versus Common mode currents, Differential mode current emission model, Common mode current emission model, Current probes, Simple susceptibility models for wires and PCB lands: Shielded cables and surface transfer impedance.</p>   | <p><b>9</b></p>        |



|  |                 |
|--|-----------------|
| <p><b>Module – IV</b><br/> <b>Cross talk:</b> Three conductor transmission lines and crosstalk, Transmission line equations for lossless lines, The per unit length parameters: Homogeneous versus Inhomogeneous media, Wide separation approximation for wires, Numerical methods for other structures, The Inductive-Capacitive Coupling Approximation model: Frequency domain Inductive-Capacitive coupling model, Time domain Inductive-Capacitive coupling model, Lumped circuit approximate models. Shielded Wires: Per unit length parameters, Inductive and Capacitive Coupling, Effect of Shield grounding, Effect of pigtails, Effects of Multiple shields, MTL model predictions, Twisted wires: Per unit length parameters, Inductive and Capacitive Coupling, Effects of Twist, Effects of Balancing.</p> | <p><b>8</b></p> |
| <p><b>Module – V</b><br/> <b>Shielding:</b> Shielding Effectiveness, Far field Sources: Exact solution, Approximate solution, Near field sources: Near field versus far field, Electric sources, Magnetic sources, Low frequency, magnetic field shielding, Effect of Apertures. System Design for EMC: Shielding and Grounding, PCB Design, System configuration and design, Electrostatic Discharge, Electromagnetic Pulse, Diagnostic tools.</p>  | <p><b>6</b></p> |

**Text books:**

1. Paul, C., Introduction to Electromagnetic Compatibility, John Wiley & Sons, 1992.

**Reference books:**

1. Ott, W. Henry, Electromagnetic Compatibility Engineering, John Wiley & Sons, 2009.

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

The gaps in the syllabus would be met by Assignment, Lectures and presentation.

**POs met through Gaps in the Syllabus**

May be met through laboratory simulations, experiments, and design problems.

**Topics beyond syllabus/Advanced topics/Design**

1. EM Interference issues in automobiles and aircrafts.
2. EM interference issues in high speed circuit design.

**POs met through Topics beyond syllabus/Advanced topics/Design  
Assignments & Seminars**

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 1 | - | 1 | 2 | - | - | - | 1 | 1  | -  | 1  | 3                                | 1  | 2  |
| CO2            | -                      | 1 | - | 1 | 1 | - | - | - | 1 | 1  | -  | 1  | 2                                | 2  | 2  |
| CO3            | 3                      | 1 | - | 1 | 1 | - | - | - | 1 | 1  | -  | 1  | 2                                | 2  | 2  |
| CO4            | 1                      | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1  | -  | 1  | 3                                | 3  | 3  |
| CO5            | 1                      | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1  |    | 2  | 2                                | 2  | 2  |

**Correlation Levels 1, 2 or 3 as defined below:**

- 1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD2, CD5, CD8                 |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1, CD2, CD5, CD8                 |
| CD3            | Seminars  | CO3                   | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD4, CD5, CD7, CD9                 |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

## COURSE INFORMATION SHEET

**Course code:** EC373

**Course title:** Introduction to Sensor and Transducer

**Pre-requisite(s):** EC101 Basis of Electronics and Communication Engineering Co-requisite(s):

**Credits:** L: 3 T: 0 P: 0 C: 3

**Class schedule per week: 04 Class: B.**

**Tech. Semester / Level: 01/01 Branch:**

**ALL B. Tech.**

**Name of Teacher:**

### Course Objectives:

This course enables the students:

|   |  |
|---|--|
| 1 | To understand principle of transduction.                         |
| 2 | To Select a resistive/inductive sensor for specific application. |
| 3 | To design sensor based on capacitive/magnetic property.          |
| 4 | To understand the operation of radiation sensor.                 |
| 5 | To compare the operation of radiation sensor.                    |

### Course Outcomes:

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Explain the principle of transduction . Classify sensor based on different parameters like measurand, principle of operation, energy etc. |
| CO2 | Select a resistive/inductive sensor for specific application  |
| CO3 | Apply the capacitive/magnetic property for sensor design  |
| CO4 | Explain the operation of radiation sensor   |
| CO5 | Differentiate between conventional sensor and smart sensor.   |

| <b>MODULE</b>  | <b>(NO. OF LECTURE HOURS)</b> |
|--|-------------------------------|
| <b>Module-I</b><br>Definition, principle of sensing & transduction, classification and characteristics of sensor. Mechanical and Electromechanical sensor;   | <b>6</b>                      |
| <b>Module-II</b><br>Resistive : potentiometric sensor, Strain gauge: Theory, type, materials, design consideration, sensitivity, gauge factor, variation with temperature, adhesive, rosettes.; Resistive Temperature sensor.<br>Inductive sensor: common types- Reluctance change type, Mutual inductance change type, transformer action type, Magnetostrictive type, LVDT: Construction, material, output input relationship.   | <b>10</b>                     |
| <b>Module-III</b><br>Capacitive sensors: variable distance-parallel plate type, variable area- parallel plate, serrated plate/teeth type and cylindrical type, variable dielectric constant type, calculation of sensitivity; Stretched diaphragm type: microphone, response characteristics; Piezoelectric element: piezoelectric effect, charge and voltage coefficient, crystal model, materials, natural & synthetic type, their comparison, force & stress sensing, ultrasonic sensors.<br>Magnetic sensors: Sensor based on Villari effect for assessment of force, torque, proximity, Wiedemann effect for yoke coil sensors, Thomson effect, Hall effect, and Hall drive, performance characteristics; | <b>10</b>                     |
| <b>Module-IV</b><br>Radiation sensors: LDR, Photovoltaic cells, photodiodes, photo emissive cell types, materials, construction,, response, Geiger counters, Scintillation detectors;  | <b>6</b>                      |
| <b>Module-V</b><br>Smart Sensor: characteristics of a smart sensor. components of smart sensor, Construction and working of smart sensor using silicon. Information Coding/Processing, Data Communication and Automation using smart sensor.   | <b>8</b>                      |

**Text Books:**

- 1.Electrical & Electronics Measurements and Instrumentation By A.K.Shawhney, Dhanpat Rai & Sons.
- 2.Electronics instrumentation By H. S. Kalsi [TMH]

**Reference Book:**

1. “Sensors and Transducers”, 2/E By D. Patranabis

**Gaps in the syllabus (to meet Industry/Profession requirements):****POs met through Gaps in the Syllabus:****Topics beyond syllabus/Advanced topics/Design:****POs met through Topics beyond syllabus/Advanced topics/Design:**

| CD # | Course Delivery methods                                     |
|------|---|
| CD1  | Lecture by use of boards/LCD projectors/OHP projectors      |
| CD2  | Quizzes   |
| CD3  | Assignments/Seminars  |
| CD4  | Mini projects/Projects                                      |
| CD5  | Laboratory experiments/teaching aids                        |
| CD6  | Industrial/guest lectures                                   |
| CD7  | Industrial visits/in-plant training                         |
| CD8  | Self- learning such as use of NPTEL materials and internets |
| CD9  | Simulation  |

**Course Outcome (CO) Attainment Assessment tools & Evaluation procedure****Direct Assessment**

| Assessment Tool           | % Contribution during CO Assessment |
|---------------------------|-------------------------------------|
| Mid SEM Examination Marks | 25                                  |
| End SEM Examination Marks | 50                                  |
| Quizzes                   | 10+10                               |
| Assessment by teacher     | 5                                   |

**Indirect Assessment –**

1. Student Feedback on Course Outcome

## Mapping between Objectives and Outcomes

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 1 | 2 | 3 | 1 | 1 |   |   |    | 3  |    | 3                                | 1  | 2  |
| CO2            | 3                      | 2 | 2 | 2 | 3 | 1 | 1 |   |   |    | 3  |    | 2                                | 2  | 2  |
| CO3            | 3                      | 3 | 1 | 2 | 3 | 1 | 2 |   | 1 | 1  | 3  | 2  | 2                                | 2  | 2  |
| CO4            | 3                      | 2 | 1 | 2 | 3 | 1 | 2 |   | 2 | 1  | 3  | 2  | 3                                | 3  | 3  |
| CO5            | 3                      | 2 | 1 | 2 | 3 | 1 | 2 |   | 2 | 1  | 3  | 2  | 2                                | 2  | 2  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD2, CD3, CD8          |
| CD2     | Quizzes                                 | CO2            | CD1, CD2, CD3, CD8          |
| CD3     | Assignments/Seminars                    | CO3            | CD1, CD2, CD3, CD8          |
| CD4     | Mini Projects/Projects                  | CO4            | CD1, CD2, CD3, CD8          |
| CD5     | Laboratory Experiments/Teaching Aids    | CO5            | CD1, CD2, CD3, CD8          |

|     |   |  |  |
|-----|---|--|--|
| CD6 | Industrial/Guest Lectures                                   |  |  |
| CD7 | Industrial Visits/In-plant Training                         |  |  |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |  |  |
| CD9 | Simulation  |  |  |

### COURSE INFORMATION SHEET

**Course code: EC375**

**Course title: High Speed Electronic**

**Pre-requisite(s): EC101 Basics of Electronics and Communication Engineering, EC201 Electronic Devices Co- requisite(s):**

**Credits: L: 3 T: 0 P: 0 C: 3**

**Class schedule per week: 03 Class: B.**

**Tech.**

**Semester / Level: VI/03**

**Branch: ECE**

**Name of Teacher:**

#### Course Objectives

This course enables the students to:

|    |  |
|----|--|
| 1. | Understand RF Behavior of Passive Components.  |
| 2. | Interpret the Microwave Characteristics of Field Effect Transistors.and apply the perceived knowledge. |
| 3. | Appraise and analyse the Distributed System and Transmission Line Theory.                              |
| 4. | Design and Evaluate the LNA and RF Power Amplifiers.   |
| 5. | Design/create the Mixers, PLLs and Oscillators.  |

#### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Describe and illustrate the RF Behavior of Passive Components. |
|-----|--|



|     |  |
|-----|--|
| CO2 | Sketch and Explain Microwave Characteristics of Field Effect Transistors.  |
| CO3 | Diagram and explain the use of Distributed System and Transmission Line Theory. Illustrate their characteristics and analyse them. |
| CO4 | Design and schematize LNA and RF Power Amplifiers, assess their characteristics and summarize their features.                      |
| CO5 | Design and schematize Mixers, PLLs and Oscillators, assess their characteristics and summarize their features.                     |

## SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <b>Module – I</b><br><b>RF Behavior of Passive Components:</b> Interconnect at Radio Frequencies - Skin Effect, Resistors, Capacitors, Inductors, Transformers, Monolithic Transformer Realizations, Interconnect Options at High Frequencies, MOSFET as Switches, Electrostatic Discharge (ESD).  | 8                      |
| <b>Module – II</b><br><b>Microwave Characteristics of Field Effect Transistors: <i>Review of MOSFET:</i></b> Dynamic Elements, High-Frequency Figures of Merit, Technology scaling in the long-channel limit, Operation in Weak inversion; MOS device physics in short-channel regime. <b><i>Modulation-doped field-effect transistor (MODFET):</i></b> Basic Device Structure, I-V Characteristics, Equivalent Circuit and Microwave Performance, Advanced Device Structures.   | 8                      |
| <b>Module – III</b><br><b>Distributed System and Transmission Line Theory:</b> Introduction, Maxwell's equation & Kirchhoff's laws, Link between lump and distributed regimes, Driving-point impedance of iterated structures; Transmission line in more detail: Lumped model for lossy transmission line, Characteristic impedance of a lossy transmission line, The propagation constant ( $\gamma$ ), Relationship of propagation constant ( $\gamma$ ) to line parameters. Behavior of finite-length transmission lines. | 8                      |

|  |          |
|--|----------|
| <b>Module – IV</b><br><b>LNA and RF Power Amplifiers: <i>Low-noise amplifiers</i>:</b> LNA topologies; Design Examples; <b><i>RF Power Amplifiers</i>:</b> General Considerations, Class A, AB, B and C Power Amplifiers, Class D Amplifiers, Class E Amplifiers; Performance Metrics, Summary of PA Characteristics, RF PA Design Examples, Additional Design Considerations. | <b>8</b> |
| <b>Module – V</b><br><b>Mixers, PLLs and Oscillators: <i>Mixers</i>:</b> Active Downconversion Mixers; Upconversion Mixers. <b><i>Phase-Locked Loops</i>:</b> General considerations: Transceiver architectures, Basic Concepts. <b><i>Oscillators</i>:</b> Performance parameters, basic principles.  | <b>8</b> |

**Textbooks:**

1. Thomas H. Lee, “The Design of CMOS Radio-Frequency Integrated Circuits,” 2<sup>nd</sup> ed., Cambridge University Press, 2004.
2. SM Sze, Kwok K. Ng, “Physics of Semiconductor Devices”, 3/e, Wiley-Interscience, 2006.
3. Behzad Razavi, RF Microelectronics, 1e, Prentice Hall, 1998.
4. Behzad Razavi, RF Microelectronics, 2e, Prentice Hall, 2012.

**Reference books:**

1. John W. M. Rogers, Calvin Plett, Radio Frequency Integrated Circuit Design, Artech House, 2010.
2. Reinhold Ludwig and Pavel Bretchko, RF Circuit Design Theory and Application, Pearson Education, 2000.

**Gaps in the syllabus (to meet Industry/Profession requirements):**

1. Hands-on-practical for IC (Integrated Circuit) fabrication.

**POs met through Gaps in the Syllabus:**

10

**Topics beyond syllabus/Advanced topics/Design:**

N/A

**POs met through Topics beyond syllabus/Advanced topics/Design:**

10

**Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure**

**Direct Assessment**

| Assessment Tool | % Contribution during CO Assessment |
|-----------------|-------------------------------------|
| First Quiz      | 10                                  |

|                          |    |
|--------------------------|----|
| Mid Semester Examination | 25 |
| Second Quiz              | 10 |
| Teacher's Assessment     | 5  |
| End Semester Examination | 50 |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO2            | 3                      | 3 | 2 | 3 | 3 | 3 | 2 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO3            | 3                      | 3 | 2 | 3 | 3 | 3 | 2 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO4            | 3                      | 3 | 2 | 3 | 3 | 2 | 2 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO5            | 3                      | 3 | 2 | 3 | 3 | 2 | 2 |   |   | 3  |    | 3  | 3                                | 2  | 1  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High) **Mapping**

### Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD7, CD 8              |
| CD2     | Tutorials/Assignments                   | CO2            | CD1 and CD9                 |
| CD3     | Seminars                                | CO3            | CD1, CD2 and CD3            |
| CD4     | Mini Projects/Projects                  | CO4            | CD1 and CD2                 |

|     |   |     |             |
|-----|---|-----|-------------|
| CD5 | Laboratory Experiments/Teaching Aids                        | CO5 | CD1 and CD2 |
| CD6 | Industrial/Guest Lectures                                   |     |             |
| CD7 | Industrial Visits/In-plant Training                         |     |             |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |     |             |
| CD9 | Simulation  |     |             |

### COURSE INFORMATION SHEET

**Course Code: EC 377**

**Course Title: Introduction to Communication System**

**Pre-requisite(s):** Good understanding of mathematical tools like integration, differentiation etc.

**Co- requisite(s):**

**Credits:** L: 3 T: 0 P: 0

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: OE/Three**

**Branch: Electronics & Communication Engineering Name of Teacher:**

#### Course Objectives

This course envisions to impart to students to:

|   |   |
|---|---|
| 1 | Explain basics of analog and digital communication system and modulation-demodulation schemes |
| 2 | Explain the method to design analog and digital modulation-demodulation system                |

|   |   |
|---|---|
| 3 | Explain the concept of sampling, quantization and coding required for various Pulse modulation schemes. |
| 4 | Explain the concept of multiplexing schemes   |
| 5 | Explain to evaluate the performance of communication system in the presence of noise.                   |

### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Demonstrate an understanding on communication system and representation of signals.  |
| CO2 | Demonstrate an understanding on different methods of Analog and Digital modulation and demodulation schemes.                 |
| CO3 | Demonstrate an understanding on design, operation and applications of Analog and Digital modulation and demodulation schemes |
| CO4 | Demonstrate an understanding on Multiplexing Scheme and Heterodyne receiver  |
| CO5 | Evaluate the performance of communication system in the presence of noise.   |

### SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <b>Module – I</b><br>Overview of electronic communication systems, need for modulation, amplitude modulation, generation and detection of AM waves, DSB-SC modulation, generation and detection of DSB-SC waves, SSB modulation and demodulation, comparison between AM, DSB-SC and SSB, frequency division multiplexing, noise in communication system, signal to noise ratio, Shannon’s theorem, channel capacity, bandwidth S/N trade-off. | <b>10</b>              |
| <b>Module – II</b><br>Angle modulation, frequency modulation and phase modulation, NBFM, WBFM, generation of FM wave, demodulation of FM wave, superheterodyne receiver, Frequency Division Multiplexing.   | <b>10</b>              |

|  |          |
|--|----------|
| <b>Module – III</b><br>Pulse modulation: sampling theorem, pulse amplitude modulation, time division multiplexing, PAM modulator and demodulator, pulse duration modulation, PDM modulator and demodulator, pulse position modulation, PPM modulator and demodulator. Analog to digital conversion:, quantization process, pulse code modulation, differential pulse code modulation, delta modulation | <b>7</b> |
| <b>Module – IV</b><br>Digital modulation and transmission: BFSK, DPSK, QPSK, M-ary PSK, QASK, BFSK, M-ary FSK, MSK, pulse shaping to reduce inter-channel and inter-symbol interference. Spread spectrum modulation and its use, PN sequence generation and its characteristics,   | <b>6</b> |
| <b>Module – V</b><br>Noise in communication system, various types of noise, equivalent noise band width, noise temperature, signal to noise ratio, noise figure, shannon’s theorem, channel capacity, bandwidth S/N trade-off, mutual information and channel capacity   | <b>7</b> |

**Text Books:**

1. Herbert Taub, Donald L Schilling and Gautam Saha “Communication Systems” McGraw Hill Education (India), pvt. Ltd., New Delhi, 4<sup>th</sup> edition, 2013.

**Reference Books:**

1. Simon Haykin, “Communication Systems” Wiley, 4<sup>th</sup> edition, 2001.
2. D. Roddy & J. Coolen, “Electronics Communication”, 4<sup>th</sup> Edition, PHI, 2005

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

**POs met through Gaps in the Syllabus:**

**Topics beyond syllabus/Advanced topics/Design**

**POs met through Topics beyond syllabus/Advanced topics/Design: PO2**

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool | % Contribution during CO Assessment |
|-----------------|-------------------------------------|
|-----------------|-------------------------------------|

|                          |    |
|--------------------------|----|
| First Quiz               | 10 |
| Mid Semester Examination | 25 |
| Second Quiz              | 10 |
| Teacher's Assessment     | 5  |
| End Semester Examination | 50 |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |   |   |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|---|---|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1                                | 2 | 3 |
| CO1            | 3                      | 2 | 2 | 1 | - | - | - | - | - | -  | -  | 2  | 3                                | 2 | 1 |
| CO2            | 3                      | 3 | 3 | 3 | 2 | - | - | - | - | -  | -  | 1  | 3                                | 2 | 2 |
| CO3            | 3                      | 3 | 3 | 3 | 2 | - | - | - | - | -  | -  | 1  | 3                                | 2 | 1 |
| CO4            | 3                      | 3 | 3 | 3 | 3 | - | - | - | - | -  | -  | 1  | 3                                | 2 | 3 |
| CO5            | 3                      | 3 | 3 | 3 | 2 | - | - | - | - | -  | -  | 1  | 3                                | 2 | 2 |

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD8                    |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1 ,CD8                    |
| CD3     | Seminars  | CO3            | CD1, CD8                    |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1, CD8                    |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD1,CD8                     |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9     | Simulation  |                |                             |

## COURSE INFORMATION SHEET

**Course Code: EC379**

Course title: **Control Systems**

Pre-requisite(s): EC205 Signals and Systems Co-requisite(s):

Course type: Core

Credits: L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B.E

Semester / Level: VII/IV

Branch: ECE Name

of Teacher:

### **Course Objectives**

This course envisions to impart to students to:

|   |  |
|---|--|
| 1 | Basic understanding of control system and its types.   |
| 2 | Represent any Linear system to using transfer function concept.                                |
| 3 | Explain the concept of system modelling.   |
| 4 | Explain the time domain analysis to understand the behavior of linear system/Nonlinear system. |
| 5 | Analyze the system using Frequency domain approach.  |

### **Course Outcomes**

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Basic understanding of control system and its types.   |
| CO2 | Represent any Linear system to using transfer function concept.                                |
| CO3 | Explain the concept of system modelling.   |
| CO4 | Explain the time domain analysis to understand the behavior of linear system/Nonlinear system. |
| CO5 | Analyze the system using Frequency domain approach.  |



## SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b></p> <p><b>MODULE – I</b> Introduction:, Examples of control systems and applications, Basic components of control systems, Open loop and closed loop control systems, Effect of feedback on overall gain, Stability and external disturbances, Classification of control system : Linear and nonlinear continuous and digital, Time invariant and time varying, Minimum phase and non-minimum phase systems etc. Linearization of nonlinear systems using Taylor’s series.</p>   | <b>6</b>               |
| <p><b>Module – II</b></p> <p>Control System Components and Basic Control Actions: Sensors and encoders in control system, Potentiometer, Tachometers, incremental encoders, Synchros, Block Diagrams and Signal Flow Graph: Block diagrams of control systems, Block diagram reduction, Signal Flow Graph (SFG) - Basic properties of SFG, SFG algebra, Gain formula to SGP, Application of gain formula to block diagrams.</p>   | <b>10</b>              |
| <p><b>Module – III</b></p> <p>Time Response of Control Systems: Transient and steady state response, Time response specifications, typical test signals, Steady state error, and error constant, Stability- Absolute, relative and conditional stability, Dominant poles of transfer function. Root Locus Methods: Root locus concept, Properties and construction of root locus, Determination of relative stability from root locus, Root sensitivity to parameter variation, Root contours, Systems with transportation lag and effect of adding poles or zeros.</p> | <b>8</b>               |
| <p><b>Module – IV</b></p> <p>Concepts of State, State Variables: Development of state-space models. State and state equations, State equations from transfer function Transfer function from state equations, State transition matrix, Solution of State equation, Transfer Matrix, State variables and linear discrete time systems, Controllable and</p>  | <b>10</b>              |

|   |          |
|---|----------|
| observable State models, Asymptotic state observers. Control system design via pole placement. Design of P, PI, PD and PID controllers.   |          |
| <b>Module – V</b><br>Bode Analysis and Introduction to Design: Frequency response specifications, Correlation between time and frequency domain Bode plot, Determination of stability using Bode plot, Introduction to compensation design using Bode plot. Other Frequency Domain Tools: Nyquist stability criterion, Theory of Magnitude phase plot, Constant M, constant N circle and Nichols chart. | <b>6</b> |

**Text Books:**

1. I. J. Nagrath & Gopal, "Control Systems Engineering", 4th Edition New Age International Publication.
2. K. Ogata, "Modern Control Engineering", 3rd Edition, Pearson Education.

**Reference Books:**

1. Norman Nise, "Control System Engineering, 4th Edition, Wiley.
2. Graham C. Goodwin, "Control System Design", PHI.
3. B. C. Kuo, "Automatic Control System", 7th Edition, PHI.

**Gaps in the syllabus (to meet Industry/Profession requirements): N/A**

**POs met through Gaps in the Syllabus:**

**Topics beyond syllabus/Advanced topics/Design:**

**POs met through Topics beyond syllabus/Advanced topics/Design:**

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  | 3                                | 3  | 2  |
| CO2            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  | 3                                | 3  | 2  |
| CO3            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 3 | 3 | 3  | 3  | 3  | 3                                | 3  | 2  |
| CO4            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  | 3                                | 3  | 2  |
| CO5            | 1                      | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1  | 2  | 1  | 3                                | 3  | 2  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, and CD 8               |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1, and CD 8               |
| CD3     | Seminars  | CO3            | CD1, and CD 8               |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1, and CD 8               |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD1, and CD 8               |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9     | Simulation  |                |                             |

## COURSE INFORMATION SHEET

**Course Code: EC381**

**Course Title: Error Correcting Codes Pre-requisite(s):** Digital communication **Co-requisite(s):**

**Credits:** L: 3 T: 0 P: 0 C:3

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: Six/Three**

**Branch: Electronics & Communication Engineering Name of Teacher:**

### **Course Objectives**

This course envisions to impart to students to:

|    |   |
|----|---|
| 1. | An understanding of Mathematical Preliminaries for error correcting codes and fundamental knowledge of block codes. |
| 2. | An understanding of BCH and Reed-Solomon Codes with its applications.   |
| 3. | Fundamental understanding on Convolutional codes & Viterbi decoding   |
| 4. | Fundamental understanding on Trellis coded modulation.  |
| 5. | Fundamental understanding on Modern iterative coding (Turbo codes and LDPC codes).                                  |

### **Course Outcomes**

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Utilize the fundamental knowledge of block codes for concerned applications.    |
| CO2 | Demonstrate the BCH and Reed-Solomon Codes for practical applications.          |
| CO3 | Have an ability to demonstrate the Convolutional encoding with Vitebi decoding. |

|     |  |
|-----|--|
| CO4 | Have an ability to demonstrate Trellis coded modulation.                                 |
| CO5 | Have an ability to demonstrate the Modern iterative coding (Turbo codes and LDPC codes). |

## SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <b>Module – I</b><br><b>Mathematical Preliminaries and Block codes</b><br>Fields, groups, and subgroups; Binary Linear Block Codes; Singleton bound; Hamming Bound; Syndrome decoding;   | 9                      |
| <b>Module – II</b><br><b>BCH and Reed-Solomon Codes</b><br>BCH Codes; Reed-Solomon Codes; Decoding BCH and RS Codes; Finding the Error Locator Polynomial: Berlekamp-Massey Algorithm; Non-Binary BCH and RS Decoding: Forney's Algorithm. | 9                      |
| <b>Module – III</b><br><b>Convolutional codes and Trellis coded modulation</b><br>Coding gain; ML and MAP decoders; Soft-versus hard-decision decoding; Convolutional Codes: Encoders and Viterbi decoding; Trellis coded modulation.      | 8                      |
| <b>Module – IV</b><br><b>Turbo codes</b><br>Encoders, Turbo decoder. Implementation aspects of turbo codes: MAP decoder and MAXLOGMAP decoder for convolutional codes, design and architecture, Turbo codes in the WiMax/3GPP standards.   | 8                      |
| <b>Module – V</b><br><b>Low density parity check codes</b><br>Low-density Parity-check Codes: Ensembles of LDPC codes, Message-passing decoders, Threshold phenomenon and density evolution. LDPC codes in the WiMax standard.             | 6                      |

|  |  |
|--|--|
|  |  |
|--|--|

**Text Books:**

1. Error Correction Coding Mathematical Methods and Algorithms” by Todd K. Moon, WileyIndia Edition.
2. “ErrorControl Coding, Second Edition”, by Shu Lin and D. J. Costello, Pearson Press, 2004.

**Gaps in the Syllabus (to meet Industry/Profession requirements) :Nil**

**POs met through Gaps in the Syllabus: NA**

**Topics beyond syllabus/Advanced topics/Design:**

**POs met through Topics beyond syllabus/Advanced topics/Design:**

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:PO1**

**Direct Assessment**

| <b>Assessment Tool</b>   | <b>% Contribution during CO Assessment</b> |
|--------------------------|--|
| First Quiz               | 10   |
| Mid Semester Examination | 25   |
| Second Quiz              | 10   |
| Teacher’s Assessment     | 5  |
| End Semester Examination | 50   |

**Indirect Assessment**

1. Students’ Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 1 |   |   |   |   |   |   |   |    |    |    | 3                                | 2  | 1  |
| CO2            | 3                      | 3 |   |   |   | 1 |   |   |   |    |    |    | 3                                | 2  | 2  |
| CO3            | 3                      | 3 |   |   |   | 1 |   |   |   |    |    |    | 3                                | 2  | 1  |
| CO4            | 3                      | 3 |   |   |   | 1 |   |   |   |    |    |    | 3                                | 2  | 3  |
| CO5            | 3                      | 3 | 1 | 3 |   | 1 | 1 |   |   |    |    | 2  | 3                                | 2  | 2  |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD8                    |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1 ,CD8                    |
| CD3     | Seminars  | CO3            | CD1, CD8                    |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1, CD8                    |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD1,CD8                     |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9     | Simulation  |                |                             |

## COURSE INFORMATION SHEET

**Course Code: EC 383**

**Course Title: DSP Architecture for VLSI**

**Pre-requisite(s):** Electronic Devices, VLSI Systems, Digital Signal Processing **Co-requisite(s):**

**Credits:** L: 3 T: 0 P: 0

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: VI**

**Branch: Electronics & Communication Engineering Name of Teacher:**

### **Course Objectives**

This course envisions imparting to students to:

|    |  |
|----|--|
| 1. | Understand the concept of DSP, FIR filters and show the FPGA implementation in DSP             |
| 2. | Analyze transformation techniques and implement the FPGA.                                      |
| 3. | Recognize the pipelining and parallel processing for IIR filters using FPGA.                   |
| 4. | Develop the algorithms for fast convolution and synchronous pipelining and implement the FPGA. |
| 5. | Demonstrate the asynchronous pipelining using FPGA.  |

### **Course Outcomes**

After the completion of this course, students will be able to:



|     |   |
|-----|---|
| CO1 | Recognize the concept of DSP, FIR filters and FPGA for DSP.                           |
| CO2 | Demonstrate the transformation techniques and demonstrate the implementation of FPGA. |
| CO3 | Apply the knowledge of pipelining and parallel processing for IIR filters using FPGA. |
| CO4 | Develop the algorithms for fast convolution and synchronous pipelining using FPGA     |
| CO5 | Show the asynchronous pipelining using FPGA.  |

## SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b></p> <p><b>An overview of DSP concepts:</b> Pipelining of FIR filters. Parallel processing of FIR filters, Pipelining and parallel processing for low power, Combining Pipelining and Parallel Processing. FPGA Architecture.</p>                 | <b>8</b>               |
| <p><b>Module – II</b></p> <p>Transformation Techniques: Iteration bound, Retiming, Folding and Unfolding, Implementation of FGPA in DSP.</p>  | <b>8</b>               |
| <p><b>Module – III</b></p> <p><b>Digital Filters:</b> Pipeline interleaving in digital filters, Pipelining and parallel processing for IIR filters, Low power IIR filter design using pipelining and parallel processing, Pipelined adaptive digital filters.</p>     | <b>8</b>               |
| <p><b>Module – IV</b></p> <p><b>Algorithms for fast convolution:</b> Cook-Toom Algorithm, Cyclic Convolution. Algorithmic strength reduction in filters and transforms: Parallel FIR Filters, DCT and inverse DCT, Parallel Architectures for Rank-Order Filters.</p> | <b>8</b>               |

|  |                 |
|--|-----------------|
| <p><b>Module – V</b></p> <p><b>Synchronous, Wave, and Asynchronous Pipelines:</b> Synchronous pipelining and clocking styles, clock skew and clock distribution in bit level pipelined VLSI designs. Wave pipelining, constraint space diagram and degree of wave pipelining, Implementation of wave-pipelined systems, Asynchronous pipelining.</p> | <p><b>8</b></p> |
|--|-----------------|

**Text Books:**

1. K.K.Parhi, VLSI Digital Signal Processing Systems, John-Wiley, 2007

**Reference Books:**

1. U. Meyer -Baese, Digital Signal Processing with FPGAs, Springer, 2004
2. Wayne Burleson, Konstantinos Konstantinides, Teresa H. Meng, VLSI Signal Processing, 1996.
3. Richard J. Higgins, Digital signal processing in VLSI, 1990.
4. Sun Yuan Kung, Harper J. Whitehouse, VLSI and modern signal processing, 1985
5. Magdy A. Bayoumi, VLSI Design Methodologies for Digital Signal Processing, 2012
6. Earl E. Swartzlander, VLSI signal processing systems, 1986.
7. Recent literature in Optimizations of Digital Signal Processing Structures for VLSI.
- 8.

**Gaps in the syllabus (to meet Industry/Profession requirements):** N/A

**POs met through Gaps in the Syllabus:** PO8 will be met through report writing/presentation based assignment

**Topics beyond syllabus/Advanced topics/Design:** Teaching through latest research paper

**POs met through Topics beyond syllabus/Advanced topics/Design:** Teaching through paper

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |

|                          |    |
|--------------------------|----|
| Teacher's Assessment     | 5  |
| End Semester Examination | 50 |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2  | 3  | 2  | 3                                | 3  | 1  |
| CO2            | 3                      | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3  | 3  | 2  | 3                                | 3  | 2  |
| CO3            | 3                      | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2  | 2  | 2  | 3                                | 3  | 2  |
| CO4            | 3                      | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3  | 2  | 2  | 3                                | 3  | 1  |
| CO5            | 3                      | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2  | 3  | 2  | 3                                | 3  | 1  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|------|---|----------------|-----------------------------|
| CD1  | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD7, CD8               |
| CD2  | Tutorials/Assignments                   | CO2            | CD1 and CD9                 |
| CD3  | Seminars                                | CO3            | CD1, CD2 and CD3            |
| CD4  | Mini Projects/Projects                  | CO4            | CD1 and CD2                 |
| CD5  | Laboratory Experiments/Teaching Aids    | CO5            | CD1 and CD2                 |
| CD6  | Industrial/Guest Lectures               |                |                             |
| CD7  | Industrial Visits/In-plant Training     |                |                             |

|     |   |  |  |
|-----|---|--|--|
| CD8 | Self- learning such as use of NPTEL Materials and Internets |  |  |
| CD9 | Simulation  |  |  |

### COURSE INFORMATION SHEET

**Course Code: EC 385**

**Course Title: Physical Design Automation Pre-**

**requisite(s):** Electronic devices, VLSI Systems **Co-requisite(s):**

**Credits:** L: 3 T: 0 P: 0

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level:**

**Branch: Electronics & Communication Engineering Name of Teacher:**

#### **Course Objectives**

This course envisions imparting to students to:

|    |  |
|----|--|
| 1. | Recognize the requirement of VLSI design automation tools.   |
| 2. | Analyze the layout compaction, placement and routing in Chip design                                    |
| 3. | Understand the role of floor planning & routing in complex ICs design.                                 |
| 4. | Utilize the capability of EDA tools for analysis, simulations and logic synthesis of complex circuits. |
| 5. | Show the high level synthesis for development of hardware model  |

#### **Course Outcomes**

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Recognize the importance of EDA tools for VLSI Circuit design. |
|-----|--|

|     |  |
|-----|--|
| CO2 | Apply the knowledge of layout compaction, placement and routing for complex chip design.               |
| CO3 | Develop a floor planning & routing skills for complex ICs design.                                      |
| CO4 | Utilize the capability of EDA tools for analysis, simulations and logic synthesis of complex circuits. |
| CO5 | Demonstrate the high level synthesis for development of hardware model                                 |

## SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <p><b>Module – I</b></p> <p><b>VLSI Design Automation:</b> Introduction of EDA Tools, algorithms and system design, Structural and logic design, Transistor level design, Layout design, Verification methods, Design management tools.</p>  | <b>7</b>               |
| <p>Module – II</p> <p><b>Layout Design Techniques:</b> Layout compaction, placement and routing, Design rules, symbolic layout, Applications of compaction, Formulation methods, Algorithms for constrained graph compaction, Circuit representation, Wire length estimation, Placement algorithms, Partitioning algorithms.</p> | <b>9</b>               |
| <p><b>Module – III</b></p> <p><b>Floor Planning and Routing:</b> Floor planning concepts, Shape functions and floor planning sizing, local routing. Area routing, Channel routing, global routing and its algorithms.</p>  | <b>8</b>               |
| <p><b>Module – IV</b></p> <p><b>Simulation and Logic Synthesis:</b> Gate level and switch level modeling and simulation, Introduction to combinational logic synthesis, ROBDD principles, implementation, construction and manipulation, twolevel logic synthesis.</p>   | <b>8</b>               |

|   |          |
|---|----------|
| <b>Module – V</b>   | <b>8</b> |
| <b>High-level Synthesis:</b> Hardware model for high level synthesis, Internal representation of input algorithms, Allocation, assignment and scheduling, Scheduling algorithms, Aspects of assignment, High Level transformations. |          |

**Text Books:**

1. S.H. Gerez, “Algorithms for VLSI Design Automation”, John Wiley, 1998.
2. N.A.Sherwani, “Algorithms for VLSI Physical Design Automation”, (3/e), Kluwer, 199.

**Reference Books:**

1. S.M. Sait, H. Youssef, “VLSI Physical Design Automation”, World scientific, 1999.
2. M.Sarrafzadeh, “Introduction to VLSI Physical Design”, McGraw Hill (IE), 1996.
3. Recent literature in Physical Design Automation.

**Gaps in the syllabus (to meet Industry/Profession requirements):** N/A

**POs met through Gaps in the Syllabus:** PO8 will be met though report writing/presentationbased assignment

**Topics beyond syllabus/Advanced topics/Design:** Teaching through latest research paper

**POs met through Topics beyond syllabus/Advanced topics/Design:** Teaching through paper

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher’s Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students’ Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2  | 3  | 2  | 2                                | 3  | 2  |
| CO2            | 3                      | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3  | 3  | 2  | 2                                | 3  | 2  |
| CO3            | 3                      | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2  | 2  | 2  | 2                                | 3  | 1  |
| CO4            | 3                      | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3  | 2  | 2  | 2                                | 3  | 1  |
| CO5            | 3                      | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2  | 3  | 2  | 2                                | 3  | 1  |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|------|---|----------------|-----------------------------|
| CD1  | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD7, CD8               |
| CD2  | Tutorials/Assignments                                       | CO2            | CD1 and CD9                 |
| CD3  | Seminars  | CO3            | CD1, CD2 and CD3            |
| CD4  | Mini Projects/Projects                                      | CO4            | CD1 and CD2                 |
| CD5  | Laboratory Experiments/Teaching Aids                        | CO5            | CD1 and CD2                 |
| CD6  | Industrial/Guest Lectures                                   |                |                             |
| CD7  | Industrial Visits/In-plant Training                         |                |                             |
| CD8  | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9  | Simulation  |                |                             |

## COURSE INFORMATION SHEET

**Course Code: EC387**

**Course Title: Wireless Communication**

**Pre-requisite(s):** Knowledge of analog and digital communication **Co-requisite(s):**

**Credits:** L: 3 T: 0 P: 0 C:3

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: Six/Three**

**Branch: Electronics & Communication Engineering Name of Teacher:**

### **Course Objectives**

This course envisions to impart to students to:

|    |  |
|----|--|
| 1. | An understanding on functioning of wireless communication system and evolution of different wireless communication systems and standards and various multiple access techniques. |
| 2. | An understanding on cellular concept, cellular architecture and evolution of different generations and standards for mobile cellular communication.                              |
| 3. | An ability to analyze different channel parameters, causes of impairments in signal propagation and impairment removal techniques.   |
| 4. | An ability to explain the architecture, functioning and protocols of various wireless communication networks.  |
| 5. | An ability to explain the capabilities and application of various wireless communication networks  |

### **Course Outcomes**

After the completion of this course, students will be able to:



|     |  |
|-----|--|
| CO1 | Demonstrate an understanding on functioning of wireless communication system and evolution of different wireless communication systems and standards and various multiple access techniques. |
| CO2 | Demonstrate an understanding on cellular concept, cellular architecture and evolution of different generations and standards for mobile cellular communication.                              |
| CO3 | Analyze different channel parameters, causes of impairments in signal propagation and impairment removal techniques.   |
| CO4 | Explain the architecture, functioning and protocols of various wireless communication networks.  |
| CO5 | Explain the capabilities and application of various wireless communication networks.   |

## SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b><br/> <b>Overview of wireless communication</b><br/> An overview of wireless communication, future vision, history of wireless communication, EM spectrum, basic elements in wireless communication systems, wireless communication system and standards: satellite communication system, GPS, paging system, cordless phone, wireless local loop, RFID.</p>                      | <b>9</b>               |
| <p><b>Module – II</b><br/> <b>Cellular communication and frequency reuse</b><br/> General architecture of a cellular system, hand-off in a cellular system, co-channel interference and adjacent channel interference, power control, evolution of mobile cellular communication (1G, 2G, 2.5G, 3G and beyond), typical cellular standards (AMPS, GSM, GPRS, WCDMA, LTE, concept of LTE-advanced.</p> | <b>9</b>               |

|   |          |
|---|----------|
| <p><b>Module – III</b><br/> <b>Mobile cellular environment</b><br/> Multipath propagation and fading, free space propagation model, propagation path loss, outdoor and indoor propagation models, channel parameters (delay spread, doppler spread, coherence bandwidth, coherence time, LCR and ADF).</p>              | <b>8</b> |
| <p><b>Module – IV</b><br/> <b>Wireless communication networks</b><br/> Wireless personal area networks (Bluetooth, UWB and ZigBee), wireless local area networks (IEEE 802.11, network architecture, medium access methods, WLAN standards), wireless metropolitan area networks (WiMAX), Ad-hoc wireless networks.</p> | <b>8</b> |
| <p><b>Module – V</b><br/> <b>Multiple access schemes</b><br/> Duplexing schemes, FDMA, TDMA, SDMA, spread spectrum technique and CDMA, OFDMA, ALOHA and CSMA.</p>   | <b>6</b> |

**Text Books:**

1. Vijay K Garg, “Wireless Communications and Networks”, Morgan Kaufmann Publishers an Imprint of Elsevier, USA 2009 (Indian reprint)

**Reference Books:**

1. Simon Haykin and Michael Moher, “Modern Wireless Communications”, Parson Education, Delhi, 2005
2. Sanjay Kumar, “Wireless Communication the Fundamental and Advanced Concepts” River Publishers, Denmark, 2015 (Indian reprint).

**Gaps in the Syllabus (to meet Industry/Profession requirements) :Nil**

**POs met through Gaps in the Syllabus: NA**

**Topics beyond syllabus/Advanced topics/Design:**

**POs met through Topics beyond syllabus/Advanced topics/Design:**

## Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:PO1

### Direct Assessment

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 2 | 1 | 1 | - | - | - | - | - | -  | -  | 2  | 3                                | 2  | 1  |
| CO2            | 3                      | 2 | 1 | 1 | 1 | - | - | - | - | -  | -  | 2  | 3                                | 2  | 2  |
| CO3            | 3                      | 2 | 2 | 2 | 2 | - | - | - | - | -  | -  | 2  | 3                                | 2  | 1  |
| CO4            | 3                      | 3 | 3 | 4 | 2 | - | - | - | - | -  | -  | 2  | 3                                | 2  | 3  |
| CO5            | 3                      | 3 | 3 | 4 | 2 | - | - | - | - | -  | -  | 2  | 3                                | 2  | 2  |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High) **Mapping Between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD8                           |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1 ,CD8                           |
| CD3            | Seminars  | CO3                   | CD1, CD8                           |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1, CD8                           |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1,CD8                            |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

**COURSE INFORMATION SHEET**

**Course Code: EC389**

**Course Title: Radar Signal Analysis**

**Pre-requisite(s): Microwave Theory and Techniques Co-requisite(s):**

**Credits:**        L: 3    T: 0    P: 0    C:3

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: Sixth/ third**

**Branch: Electronics & Communication Engineering Name of Teacher:**

**Course Objectives**

This course envisions to impart to students to:

|    |   |
|----|---|
| 1. | To appraise an overview of Radar Systems. |
|----|---|

|    |   |
|----|---|
| 2. | To perceive the Target Detection, Pulse Integration and Pulse Compression           |
| 3. | To grasp Matched Filter and Ambiguity Function-Analog and Discrete Coded Waveforms. |
| 4. | To understand the concept of Radar Clutter.   |
| 5. | To grasp the Doppler and Adaptive Array Processing                                  |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Able to explain the Radar Systems.  |
| CO2 | Able to demonstrate Target Detection, Pulse Integration and Pulse Compression             |
| CO3 | Able to explain Matched filter and Ambiguity Function-Analog and Discrete Coded Waveforms |
| CO4 | Able to demonstrate the Radar Clutter   |
| CO5 | Able to demonstrate the Doppler and Adaptive Array Processing                             |

### SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <b>Module – I</b><br><b>Radar Systems (an overview):</b> Range Measurements, Range Resolution, Doppler Frequency, Coherence, The Radar Equation, Surveillance Radar Equation, Radar Cross Section, Radar Equation with Jamming, Noise Figure Effects of the Earth’s Surface on the Radar Equation, Atmospheric Attenuation, | <b>10</b>              |

|   |           |
|---|-----------|
| <p><b>Module – II</b><br/> <b>Target Detection, Pulse Integration and Pulse Compression:</b> Target Detection in the Presence of Noise, Probability of False Alarm, Probability of Detection, Pulse Integration, Target Fluctuating, Probability of False Alarm Formulation for a Square Law Detector, Probability of Detection Calculation, Computation of the Fluctuation Loss, Cumulative Probability of Detection, Constant False Alarm Rate (CFAR), Time-Bandwidth Product, Radar Equation with Pulse Compression, Basic Principal of Pulse Compression, Correlation Processor, Stretch Processor</p>        | <b>10</b> |
| <p><b>Module – III</b><br/> <b>Matched Filter and Ambiguity Function:</b> The Matched Filter SNR, Mean and Variance of the Matched Filter Output, General Formula for the Output of the Matched Filter, Waveform Resolution and Ambiguity, Range and Doppler Uncertainty, Target Parameter Estimation, Examples of the Ambiguity Function, Stepped Frequency Waveforms, Nonlinear FM Ambiguity Diagram Contours, Interpretation of Range-Doppler Coupling in LFM Signals, Discrete Code Signal Representation, Pulse-Train Codes, Phase Coding, Frequency Codes, Ambiguity Plots for Discrete Coded Waveforms</p> | <b>7</b>  |
| <p><b>Module – IV</b><br/> <b>Radar Clutter:</b> Clutter Cross Section Density, Surface Clutter, Volume Clutter, Clutter RCS, Clutter Spectrum, Moving Target Indicator (MTI), PRF Staggering, MTI Improvement Factor, Subclutter Visibility, Delay Line Cancelers with Optimal Weights</p>   | <b>7</b>  |
| <p><b>Module – V</b><br/> <b>Doppler and Adaptive Array Processing:</b> CW Radar Functional Block Diagram, Pulsed Radars, Introduction to Adaptive Array Processing, General Arrays, Linear Arrays, Nonadaptive Beamforming, Adaptive Array Processing</p>  | <b>6</b>  |

**Text Books:**

1. Bassem R. Mahafza, Radar Signal Analysis and Processing Using MATLAB, Chapman and Hall/CRC, 2008.

**Reference Books:**

1. M.I. Skolnik, “Introduction to Radar Systems” 3/e, TMH, New Delhi, 2001
2. Nathanson, F. E., Radar Design Principles, New York, McGraw-Hill, 2<sup>nd</sup> Edition, 1991
3. Toomay, J. C., Radar Principles for the Non-Specialist, New York, Van Nostrand, Reinhold, 1989
4. Buderer R., The Invention That Changed the World, New York, Simon and Schuster, 1996
5. R.J Sullivan, Radar foundation for imaging & advanced concepts, PHI, 2004.
6. Mark A Richards, Fundamentals of Radar Signal Processing, McGraw-Hill Company, 2005.

## Gaps in the Syllabus (to meet Industry/Profession requirements)

**POs met through Gaps in the Syllabus:** PO8 will be met through report-writing/presentation based assignment

**Topics beyond syllabus/Advanced topics/Design :** Teaching through paper

**POs met through Topics beyond syllabus/Advanced topics/Design:** Teaching through paper

## Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

### Direct Assessment

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

## Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 3 | 2 | 2 | 1 | 1 | 3 | 2 | 3  | 3  | 3  | 3                                | 2  | 1  |
| CO2            | 3                      | 3 | 3 | 2 | 2 | 1 | 1 | 3 | 2 | 3  | 3  | 3  | 3                                | 2  | 2  |
| CO3            | 3                      | 3 | 3 | 2 | 2 | 1 | 1 | 3 | 2 | 3  | 3  | 3  | 3                                | 2  | 1  |
| CO4            | 3                      | 3 | 3 | 2 | 2 | 1 | 1 | 3 | 2 | 3  | 3  | 3  | 3                                | 2  | 3  |

|            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <b>CO5</b> | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 2 |
|------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High) **Mapping  
Between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD8                           |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1 ,CD8                           |
| CD3            | Seminars  | CO3                   | CD1, CD8                           |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1, CD8                           |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1,CD8                            |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

### **COURSE INFORMATION SHEET**

**Course Code: EC401**

Course title: **Industrial Electronics** Pre-requisite(s): EC253 Analog Electronics Co-requisite(s):

Course type: Core

Credits:            L: 3    T: 0    P: 0

Class schedule per week: 03

Class: B.E

Semester / Level: VII/IV



Branch: ECE Name  
of Teacher:

### Course Objectives

This course envisions to impart to students to:

|   |  |
|---|--|
| 1 | Understand the concepts of power semiconductor devices and their triggering schemes. |
| 2 | Apply the concepts of control rectifiers for AC to DC power conversion.              |
| 3 | Explain the commutation process in power semiconductor devices                       |
| 4 | Understand the operations of Inverter and Choppers                                   |
| 5 | Design the DC and AC motor drives for speed control.                                 |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Describe the functionality of power semiconductor devices and their triggering schemes. |
| CO2 | Explain the concept of controlled rectifiers for AC to DC power conversion.             |
| CO3 | Explain the commutation process in power semiconductor devices                          |
| CO4 | Demonstrate the operations of Inverter and Choppers                                     |
| CO5 | Design the DC and AC motor drives for speed control.                                    |

### SYLLABUS

| MODULE | (NO. OF LECTURE HOURS) |
|--------|------------------------|
|--------|------------------------|

|  |           |
|--|-----------|
| <p><b>Module – I</b><br/> <b>Introduction</b><br/> Silicon Controlled Rectifier (SCR), SCR construction, Two transistor analogy, Characteristics, Gate characteristics, Different types of SCR. Construction and characteristics of DIAC and TRIAC.<br/> Triggering Schemes: dv/dt, Thermal, Light and Gate Triggering, Gate triggering using R and RC firing circuits, Firing circuit using UJT and 555 Timer, SCR protection.</p>                      | <b>6</b>  |
| <p><b>Module – II</b><br/> Controlled Rectifiers:<br/> Analysis of single-phase Half Wave and Full Wave controlled rectifiers with resistive load and RL load, Flywheel diode, Circuit operation of Half controlled and fully controlled Bridge Rectifiers with Resistive and RL load. Three phasecontrolled Rectifiers; Circuit operation of three phase Half Wave and Full Wave controlled Rectifier circuits. DC and AC Voltage Regulators, SMPS.</p> | <b>10</b> |
| <p><b>Module – III</b><br/> Commutation:<br/> Natural and Forced Commutation, Self-Commutation, Impulse Commutation, Resonant Pulse Commutation, Complementary Commutation, Load Side Commutation, Line Side Commutation.</p>  | <b>8</b>  |
| <p><b>Module – IV</b><br/> Inverters:<br/> Principle and operation, Inverter classification, Voltage and Current driven Inverters, Single phase Inverters, Inverter circuits with Mc-Murray Commutation and Mc-Murray Bedford Commutation.<br/> Choppers:<br/> Basic Chopper Circuit, Types of Choppers, Step up and step-down choppers, Type A Chopper, Type B Chopper, Type C Chopper.</p>   | <b>10</b> |
| <p><b>Module – V</b><br/> DC and AC Motor Control:<br/> DC Motor, One Quadrant and Two Quadrant Single Phase SCR Drive for DC Motor, AC Motor, Speed Control Methods for Induction Motor, Cycloconverters. Non-Motor Industrial Applications; Resistance Welding, Induction Heating, Dielectric Heating.</p>   | <b>6</b>  |

**Text Books:**

1. Power Electronics by P.C. Sen., Tata McGraw Hill
2. Power Electronics Circuits, Devices and Application, by Muhammad H. Rashid

**Reference Books:****Gaps in the syllabus (to meet Industry/Profession requirements): N/A****POs met through Gaps in the Syllabus:****Topics beyond syllabus/Advanced topics/Design:****POs met through Topics beyond syllabus/Advanced topics/Design:****Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure****Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            |                        |   |   |   |   |   |   |   |   |    |    |    |                                  |    |    |
| CO2            |                        |   |   |   |   |   |   |   |   |    |    |    |                                  |    |    |
| CO3            |                        |   |   |   |   |   |   |   |   |    |    |    |                                  |    |    |
| CO4            |                        |   |   |   |   |   |   |   |   |    |    |    |                                  |    |    |
| CO5            |                        |   |   |   |   |   |   |   |   |    |    |    |                                  |    |    |

**Correlation Levels 1, 2 or 3 as defined below:**

- 1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, and CD 8                      |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1, and CD 8                      |
| CD3            | Seminars  | CO3                   | CD1, and CD 8                      |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1, and CD 8                      |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1, and CD 8                      |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

## COURSE INFORMATION SHEET

**Course code: EC402**

**Course title: Communication Lab.**

**Pre-requisite(s): Analog Communication**

**Co- requisite(s): Digital Communication**

**Credits: L: 0 T: 0 P: 3 C: 1.5 Class**

**schedule per week: 03 Class: B. Tech.**

**Semester / Level: Seventh/Fourth Branch:**

**Electronics & Communication Lab Name**

**of Teacher:**

### Course Objectives:

This course enables the students:

|     |   |
|-----|---|
| 21. | To develop an understanding about the Analog Modulation Techniques, V-F conversion and Butterworth LPF. |
| 22. | To develop an understanding about the signal sampling, quantization and its reconstruction              |
| 23. | To develop an ability to understand and design the various waveform coding techniques                   |
| 24. | To develop an ability to evaluate and design various digital modulation Techniques                      |
| 25. | To develop an ability to evaluate and design Time Division Multiplexing Technique                       |

### Course Outcomes:

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Demonstrate understanding of the various Analog Modulation Techniques, V-F conversion and Butterworth LPF.            |
| CO2 | Analyse the signal sampling, quantization and its reconstruction.   |
| CO3 | Design the generation and detection of various waveform coding techniques such as PCM, DM and ADM                     |
| CO4 | Design the modulators and demodulators for various digital modulation techniques such as ASK, PSK, FSK, QPSK, and QAM |
| CO5 | Design system for Time Division multiplexing Technique  |

## Syllabus

### List of Compulsory experiments:

**1.Name of the Experiment: Generation and detection of Amplitude Modulated**

AIM-1: Generation and detection of Amplitude Modulated wave and calculation of percentage modulation using ACL 01 and ACL 02 Kits

**2. Name of the Experiment: : Generation and detection of Frequency Modulated wave**

AIM-1: Generation and detection of Frequency Modulated wave using ACL 03 and ACL 04 FM trainer Kits

**3.Name of the Experiment: Investigation of Signal Sampling and Reconstruction**

AIM-1: Investigation of Signal Sampling and Reconstruction using DCL 01 Falcon kit

**4.Name of the Experiment: Investigation of TDM system**

AIM-1: Investigation of TDM system using DCL02 Falcon kit

**5.Name of the Experiment: Investigation of practical PCM system**

AIM-1: Investigation of practical PCM system using DCL03 and DCL04 Falcon kit

**6.Name of the Experiment: Investigation of ASK, FSK, PSK modulation/demodulation**

AIM-1: Design of ASK, PSK, FSK modulator/demodulator using trainer Kit

**7. Name of the Experiment: Generation and detection of DSBSC**

AIM-1: Generation and detection of **DSBSC using** ALTAIR Solid Thinking Embed/Comm

**8. Name of the Experiment: Generation and detection of PAM, PWM, PPM**

AIM-1: Design of PAM, PWM, PPM Modulation and Demodulation Systems using ALTAIR Solid Thinking Embed/Comm

**9. Name of the Experiment: Investigation of Delta Modulation system**

AIM-1: Investigation of Delta Modulation and Adaptive Delta modulation system using ALTAIR Solid Thinking Embed/Comm

**10. Name of the Experiment: Investigation of Delta Modulation and Adaptive Delta Modulation system**

AIM-1: Investigation of Delta Modulation and Adaptive Delta modulation system using ALTAIR Solid Thinking Embed/Comm

**11. Name of the Experiment: Investigation of QAM modulation and demodulation**

AIM-1: Design of QAM modulator/demodulator using ALTAIR Solid Thinking Embed/Comm

**12. Name of the Experiment: Investigation of QPSK modulation and demodulation**

AIM-1: Design of QPSK modulator/demodulator using ALTAIR Solid Thinking  
Embed/Comm

**Text Book:**

1. "Principles of Communication Systems", 2/e, by H. Taub and DL Schilling, Tata McGraw Hills, ND.
2. "Communication Systems", 4/e by Simon Haykin, John Wiley and Sons, Delhi.

**Reference Books:**

1. Simon Haykin, "Communication Systems", Wiley Eastern Limited, New Delhi, 2016, 4/e.
2. J. Schiller, "Mobile Communication" 2/e, Pearson Education, 2012.

**Gaps in the syllabus (to meet Industry/Profession requirements):** NA

**POs met through Gaps in the Syllabus:** N/A.

**Topics beyond syllabus/Advanced topics/Design:** N/A

**POs met through Topics beyond syllabus/Advanced topics/Design:** N/A

**Course Outcome (CO) Attainment Assessment tools & Evaluation procedure**

**Direct Assessment**

| Assessment Tool               | % Contribution during CO Assessment |
|-------------------------------|-------------------------------------|
| <b>Progressive Evaluation</b> | <b>(60)</b>                         |
| Attendance Marks              | <b>12</b>                           |
| Day-to-day performance Marks  | <b>06</b>                           |
| Lab Viva marks                | <b>20</b>                           |
| Lab file Marks                | <b>12</b>                           |
| Lab Quiz-I Marks              | <b>10</b>                           |
| <b>End SEM Evaluation</b>     | <b>(40)</b>                         |
| Lab Quiz-II Marks             | <b>10</b>                           |
| Lab performance Marks         | <b>30</b>                           |

**Indirect Assessment –**

1. Student Feedback on Course Outcome

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |   |   |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|---|---|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1                                | 2 | 3 |
| CO1            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 2  | 1  | 3  | 2                                | 2 | 1 |
| CO2            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 2  | 1  | 3  | 2                                | 2 | 1 |
| CO3            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 2  | 1  | 3  | 2                                | 2 | 1 |
| CO4            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 2  | 1  | 3  | 2                                | 2 | 1 |
| CO5            | 3                      | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 2  | 1  | 3  | 2                                | 2 | 1 |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods:

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD5                    |
| CD2     | Tutorials/Assignments                   | CO2            | CD1, CD5                    |
| CD3     | Seminars/ Quiz (s)                      | CO3            | CD1, CD5                    |
| CD4     | Mini Projects/Projects                  | CO4            | CD1, CD5                    |
| CD5     | Laboratory Experiments/Teaching Aids    | CO5            | CD1, CD5                    |
| CD6     | Industrial/Guest Lectures               |                |                             |



|     |   |  |  |
|-----|---|--|--|
| CD7 | Industrial Visits/In-plant Training                         |  |  |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |  |  |
| CD9 | Simulation  |  |  |

### **COURSE INFORMATION SHEET**

**Course code: EC403**

**Course title: Professional Practice Law & Ethics**

**Pre-requisite(s):** The assumed knowledge for this course is fundamental knowledge in the branch of Electronics and Communication engineering.

**Co- requisite(s):**

**Credits:** L:3 T:0 P:0

**Class schedule per week: 02 Class:**

**B. Tech.**

**Semester / Level: VII/04**

**Branch: ECE**

**Name of Teacher:**

#### **Course Objectives**

This course aims to develop

|            |   |
|------------|---|
| <b>21.</b> | Vision for holistic technologies, production systems and management models towards sustainable development in the field of electronics and communication engineering. |
| <b>22.</b> | Understanding of human being and basic human aspirations.   |
| <b>23.</b> | Understanding of universal human values and professional ethics in the light of right understanding.  |

|            |  |
|------------|--|
| <b>24.</b> | An environmental awareness and acceptance of the responsibility in making engineering decisions consistent with the safety, health and welfare of the society at large |
| <b>25.</b> | Understanding of legal requirements related to working in the field electronics and communication engineering.   |

### Course Outcomes

**After the completion of this course, students will be able to:**

|            |   |
|------------|---|
| <b>CO1</b> | Reflect vision of holistic technologies, production systems and management models towards sustainable development in the field of electronics and communication engineering.                      |
| <b>CO2</b> | Reflect understanding of human being and basic human aspirations  |
| <b>CO3</b> | Understand universal human values and professional ethics in the light of right understanding.  |
| <b>CO4</b> | Reflect and understanding of environmental awareness and acceptance of the responsibility in making engineering decisions consistent with the safety, health and welfare of the society at large. |
| <b>CO5</b> | Understand the legal requirements related to working in the field electronics and communication engineering.  |

## SYLLABUS

| <b>MODULE</b>   | <b>(NO. OF LECTURE HOURS)</b> |
|---|-------------------------------|
| <b>Module – I</b><br><br>Human Values : Morals, values and ethics, integrity, work ethics, service learning, civic virtue, respect for others, living peacefully, caring sharing honesty, courage, valuing time, cooperation commitment, empathy, self confidence, character, spirituality, introduction to Yoga and meditation for professional excellence and stress management.  | <b>8</b>                      |
| <b>Module – II</b><br><br>Profession and Human Values: Values Crisis in contemporary society Nature of values: Value Spectrum of a good life Psychological values: Integrated personality; mental health Societal values: The modern search for a good society, justice, democracy, secularism, rule of law, values in Indian Constitution. Aesthetic values: Perception and enjoyment of beauty, simplicity, clarity Moral and ethical values: Nature of moral judgments; canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility | <b>8</b>                      |
| <b>Module – III</b><br><br>Engineering ethics : Sense of engineering ethics, variant of moral issues, types of enquiry, moral dilemmas, moral autonomy, consensus and controversy, models of professional roles, theories about right action, self interest, customs and religions, use of ethical theories.  | <b>8</b>                      |
|   |                               |

|  |                 |
|--|-----------------|
| <p><b>Module – IV</b></p> <p>Ethics of Profession: Engineering profession: Ethical issues in Engineering practice, Conflicts between business demands and professional ideals. Social and ethical responsibilities of Technologists, Codes of professional ethics. Whistle blowing and beyond, Case studies.</p>   | <p><b>8</b></p> |
| <p><b>Module – V</b></p> <p>Basic understanding of the objectives and the expected contributions of the field electronics and communication engineering for sustainable development. Understanding of possible hazards in the field of electronics and communication engineering. Company law and understanding of legal requirements related to work, research and innovation in the field electronics and communication engineering.</p> | <p><b>8</b></p> |

**Text books:**

1. Mike W Martin and Roland Schinzinger, Ethics in engineering < Tata McGraw Hill New delhi, 2003
2. “Deborah Johnson, Ethical Issues in Engineering, Prentice Hall, Englewood Cliffs, New Jersey 1991.
3. A N Tripathi, Human values in the Engineering Profession, Monograph published by IIM, Calcutta.
4. Sanjay Kumar, “Healthy body and positive Mind (in Hindi),” National book trust, New, 2018.

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

3. Understanding of different judicial law of state and central governments.

**POs met through Gaps in the Syllabus**

3, 4, 12

**Topics beyond syllabus/Advanced topics/Design** Contemporary laws of the land

**POs met through Topics beyond syllabus/Advanced topics/Design**

2, 3, 4, 12

## Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

### Direct Assessment

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 1 | 1 | 1 | 2 |   |   |   | 1 | 1  |    | 2  | 3                                | 1  | 2  |
| CO2            | 2                      | 1 |   | 1 | 2 |   |   |   | 1 | 1  |    | 2  | 2                                | 2  | 2  |
| CO3            | 3                      | 1 |   | 1 | 2 |   |   |   | 1 | 1  |    | 2  | 2                                | 2  | 2  |
| CO4            | 1                      | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1  | 1  | 2  | 3                                | 3  | 3  |
| CO5            | 1                      | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1  |    | 2  | 2                                | 2  | 2  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used        |
|---------|---|----------------|------------------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD2, CD5, CD8                 |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1, CD2, CD5, CD8                 |
| CD3     | Seminars  | CO3            | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD4, CD5, CD7, CD9                 |
| CD6     | Industrial/Guest Lectures                                   |                |                                    |
| CD7     | Industrial Visits/In-plant Training                         |                |                                    |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                                    |
| CD9     | Simulation  |                |                                    |

## COURSE INFORMATION SHEET

**Course Code: EC405**

**Course Title: Digital Image and Video Processing**

**Pre-requisite(s): Digital Signal processing.**

**Co-requisite(s):**

**Credits: L: 3 T: 0 P: 0**

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: VII/04**

**Branch: Electronics and Communication Engineering Name  
of Teacher:**

### **Course Objectives**

This course envisions to impart students to:

|    |  |
|----|--|
| 1. | To gain understanding on digital image formation, characteristics and its processing steps.                          |
| 2. | To demonstrate the use of different spatial and frequency domain processing techniques to improve the image quality. |
| 3. | To apply various segmentation and compression techniques of an image.  |
| 4. | To introduce various image description and representation methods for computer vision applications.                  |
| 5. | To understand the basic video processing and coding methods.   |

### **Course Outcomes**

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Develop an understanding on the image formation, pixel characteristics and video processing step.  |
| CO2 | Have an ability to analyze the image quality using transformed and spatial domain filters.   |
| CO3 | Have an ability to segment and represent the image for computer vision tasks. Have an ability to analyze the different image and video compression techniques and to evaluate its performance. |
| CO4 | Develop an ability to apply video segmentation, motion detection and coding procedures.  |
| CO5 | Design the basic building blocks of image/video compression techniques   |

## SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b></p> <p>Fundamental steps in Digital Image Processing, Components of an Image processing system, DigitalImage Representation, Basic relationship between pixels, Basic Arithmetic/Logic operations on image: Image subtraction, Image averaging, Color image processing fundamentals: Color Modules, RGB, HIS, Lab colormodules, Convolution and Correlation theorem.</p> | <b>8</b>               |



|  |                 |
|--|-----------------|
| <p><b>Module – II</b></p> <p>Gray Level Transformations, Histogram Processing, Smoothing and Sharpening with Spatial Domain Filters, Fourier Transform, Fast Fourier Transform, Discrete Cosine Transform, Wavelet Transforms, Smoothing and Sharpening with Frequency Domain filters, Homomorphic filtering, Pseudo Color Image Enhancement, Introduction to Image Restoration.</p> | <p><b>8</b></p> |
| <p><b>Module – III</b></p> <p>Detection of Discontinuities, Point Detection, Line detection, Edge Detection, Thresholding , Optimal Global and Adaptive thresholding, Region-based Segmentation, Textural Images, Textural Feature extraction from Co-occurrence matrices, Chain codes, Signatures, Boundary Segments, Skeletons, Boundary Descriptors, Regional Descriptors.</p>    | <p><b>8</b></p> |
| <p><b>Module – IV</b></p> <p>Fundamentals of image compression, Redundancy, Image Compression Models, Coding Theorems, Error-free Compression techniques like Variable- length Coding and Lossless Predictive Coding, Lossy Compression techniques like Lossy Predictive Coding and Wavelet Coding, Image Compression Standards.</p>   | <p><b>8</b></p> |

|   |                 |
|---|-----------------|
| <p><b>Module – V</b></p> <p>Fundamentals of Video Coding- Inter-frame redundancy, motion estimation techniques – full-search, fast search strategies, forward and backward motion prediction, frame classification – I, P and B; Video sequence hierarchy – Group of pictures, frames, slices, macro-blocks and blocks; Elements of a video encoder and decoder; Video coding standards – MPEG and H.26X, Introduction to Video Segmentation.</p> | <p><b>8</b></p> |
|---|-----------------|

**Text Books:**

1. Digital Image Processing. 2/E by Rafael C. Gonzalez and Richard E. Woods. Pearson Education.
2. Digital Image Processing and Analysis. by B. Chanda and D. Dutta Mujumdar PHI
3. Ed. Al Bovik ,”Handbook of Image and Video Processing”, 2nd Edition, Academic Press, 2000.

**Reference Books:**

1. Fundamentals of Digital Image Processing. By Anil K. Jain, PHI Publication
2. Image Processing, Analysis and Machine Vision. Milan Sonka and Vaclav Hlavac.
3. A. M. Tekalp, “Digital Video Processing”, 2nd Edition, Prentice Hall, 2015.

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

NA

**POs met through Gaps in the Syllabus**

NA

**Topics beyond syllabus/Advanced topics/Design**

Teaching through Research paper

**POs met through Topics beyond syllabus/Advanced topics/Design**

2

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

## Direct Assessment

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

## Indirect Assessment

1. Students' Feedback on Course Outcome.

## Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 2                      | 3 |   | 3 | 1 |   |   |   | 1 | 2  |    | 2  | 1                                | 2  | 2  |
| CO2            | 2                      | 3 |   | 3 | 1 |   |   |   | 1 | 2  | 1  | 2  | 1                                | 2  | 3  |
| CO3            | 2                      | 3 | 2 | 3 | 1 |   |   |   | 1 | 2  | 1  | 2  | 2                                | 3  | 3  |
| CO4            | 2                      | 2 | 2 | 2 | 1 |   |   |   | 1 | 2  | 1  | 2  | 2                                | 2  | 3  |
| CO5            | 3                      | 2 | 1 | 1 | 2 |   |   |   | 1 | 1  | 1  | 2  | 3                                | 3  | 3  |

## Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD2, CD 8                     |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1 and CD9                        |
| CD3            | Seminars  | CO3                   | CD1, CD2 and CD3                   |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1 and CD2                        |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1, CD2, CD9                      |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

**COURSE INFORMATION SHEET****Course Code: EC406****Course Title: Image Processing Lab.****Pre-requisite(s): Digital Signal Processing Laboratory Co-requisite(s):****Credits: L: 0 T: 0 P: 4 C: 2****Class schedule per week: 04 Class: B.****Tech.****Semester / Level: VII****Branch: Electronics and Communication Engineering****Name of Teacher: Dr. P. P. Dash**

## Course Objectives

This course envisions to impart to students to:

|     |  |
|-----|--|
| 26. | Learn MATLAB tools and DSP board (TMS320C6748) for image processing and analysis.                          |
| 27. | Write MATLAB codes for image enhancement and image restoration.  |
| 28. | Illustrate different digital filters for removing various kind of noise in image.                          |
| 29. | Evaluate the image processing techniques in DSP board (TMS320C6748).                                       |
| 30. | Develop programming skill to implement classifier, object detector, etc. for computer vision applications. |

## Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Write the programs in MATLAB and DSP board for image processing techniques.  |
| CO2 | Implement different techniques for image enhancement.  |
| CO3 | Design various digital filters for various image processing applications.  |
| CO4 | Apply the concept to do project work on various domains of computer vision, pattern classification, pattern recognition etc. |
| CO5 | Utilize their knowledge solve problems in industry and research where, they will be in future.                               |

## **SYLLABUS**

### **LIST OF EXPERIMENTS:**

#### **Syllabus**

Lab is the application of the theory (i.e., hands-on experiments related to the course contents). Therefore, DIGITAL IMAGE AND VIDEO PROCESSING is the syllabus for the DIGITAL IMAGE PROCESSING LAB. Following experiments are the guidelines for the students. However, the questions for exams are not limited to this experiment list.

#### **List of experiments:**

1. Familiarization with MATLAB toolboxes for Digital Image Processing.
2. Write and execute a program for geometric transformation of image using MATLAB (a)  
Translation  
  
(b) Scaling  
(c) Rotation  
(d) Shrinking  
(e) Zooming
3. Write MATLAB codes for Pixel-wise transformation of a given image using the operations:
  - a. Image Negative
  - b. Logarithmic transformation
  - c. Gray level Slicing
4. Write MATLAB codes for contrast enhancement of a given image using histogram equalization.
5. Write programs for Image enhancement using spatial filters.
6. Finding the spectrum of a degraded image, identify image and noise spectrums and measure the Signal-to-Noise Ratio (SNR) using MATLAB.
7. Write a MATLAB code for image compression using Huffman coding.
8. Write a program for Edge detection of the image using Sobel algorithm in DSP board (TMS320C6748).
9. Write a program for Image Smoothing and Image Sharping using convolution functions in DSP board (TMS320C6748).
10. Write a program in MATLAB for motion estimation in a video.
11. Mini project.
12. Mini project.

#### **Text Books:**

2. Digital Image Processing using MATLAB. 2/E by Rafael C. Gonzalez and Richard E. Woods. Pearson Education.
2. Digital Image Processing and Analysis. by B. Chanda and D. Dutta Mujumdar PHI

**Reference Books:**

4. Fundamentals of Digital Image Processing. By Anil K. Jain, PHI Publication
5. Image Processing, Analysis and Machine Vision. Milan Sonka and Vaclav Hlavac.
6. A. M. Tekalp, “Digital Video Processing”, 2nd Edition, Prentice Hall, 2015.

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

There is provision of doing mini projects based on industrial requirements and applications.

**POs met through Gaps in the Syllabus**

NA

**Topics beyond syllabus/Advanced topics/Design**

Simulations based on advanced topics after completion of compulsory twelve experiments.

**POs met through Topics beyond syllabus/Advanced topics/Design**

Assignments & Seminars

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool                           | % Contribution during CO Assessment |
|---|-------------------------------------|
| Progressive Evaluation                    | <b>(60)</b>                         |
| Day to day performance and Lab file Marks | 30                                  |
| Viva Marks                                | 20                                  |
| Lab quiz Marks                            | 10                                  |
| End SEM Evaluation                        | <b>(40)</b>                         |
| Lab quiz Marks                            | 10                                  |
| Lab performance Marks                     | 30                                  |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 1  | 3  | 3  | 2                                | 1  | 1  |
| CO2            | 3                      | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 1  | 3  | 3  | 2                                | 1  | 1  |
| CO3            | 3                      | 3 | 3 | 1 | 3 | 2 | 2 | 3 | 3 | 1  | 3  | 2  | 3                                | 2  | 2  |
| CO4            | 3                      | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2  | 3  | 2  | 3                                | 3  | 2  |
| CO5            | 3                      | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 2  | 3  | 2  | 3                                | 2  | 3  |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Mapping between COs and Course Delivery (CD) methods**

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD2, CD5, CD8          |
| CD2     | Tutorials/Assignments                   | CO2            | CD1, CD2, CD5, CD8          |



|     |   |     |                                    |
|-----|---|-----|------------------------------------|
| CD3 | Seminars  | CO3 | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD4 | Mini Projects/Projects                                      | CO4 | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD5 | Laboratory Experiments/Teaching Aids                        | CO5 | CD4, CD5, CD7, CD9                 |
| CD6 | Industrial/Guest Lectures                                   |     |                                    |
| CD7 | Industrial Visits/In-plant Training                         |     |                                    |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |     |                                    |
| CD9 | Simulation  |     |                                    |

## COURSE INFORMATION SHEET

**Course Code:** EC407

**Course Title:** Multi-Channel Signal Processing

**Pre-requisite(s):** Signal Processing Techniques, Time Frequency and Wavelet Transform, Probability and Random Processes **Co- requisite(s):**

**Credits:** L: 3 T: 0 P: 0

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: VII**

**Branch: Electronics and Communication Engineering Name**

**of Teacher:**

**Course Objectives**

This course envisions to impart to students to:

|   |  |
|---|--|
| 1 | To explain the concept of Source separation problem and impart knowledge on the mathematical concept of Blind Source Separation.         |
| 2 | To develop an ability to understand the concept of Blind Source Separation tool like independent component analysis.                     |
| 3 | To develop an ability to evaluate the impact of mixing and de-mixing over BSS algorithm.   |
| 4 | To develop an ability to analyse the impact of higher orders statistics over BSS algorithm.  |
| 5 | To develop and ability to evaluate the performance of BSS algorithm in diverse areas of application with the help of practical examples. |

### **Course Outcomes**

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Demonstrate understanding on the Source separation problem and impart knowledge on the mathematical concept of Blind Source Separation. |
|-----|---|

|     |   |
|-----|---|
| CO2 | Describe and apply the concept of Blind Source Separation tool like independent component analysis. |
| CO3 | Demonstrate understanding on the impact of mixing and de-mixing system over BSS algorithm.          |
| CO4 | Analyse the impact of higher orders statistics over BSS algorithm.                                  |
| CO5 | Apply the BSS algorithm as preprocessing method before feature extraction over real time signals    |

## SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b></p> <p>Introduction to Multi-channel Signal Processing, Cocktail Party Problem, The Geometry of Mixtures, Un-mixing Using the Inner Product, Principal Component Analysis, Uncorrelatedness and whitening, Whitening transform, Robust Prewhitening</p>  | <p><b>8</b></p>        |
| <p><b>Module – II</b></p> <p>Blind Source Separation, Blind Source Separation via Generalized Eigenvalue Decomposition, Methods using time structure, Separation by Autocovariances, The AMUSE algorithm, The SOBI algorithms, Separation by non-stationarity of variances, The SEONS algorithms, A fixed-point algorithm, Convolutional Mixtures and Blind Deconvolution, Bussgang Methods, Cumulant-based methods, The convolutional BSS problem, Natural gradient methods, Spatiotemporal de-correlation methods</p> | <p><b>9</b></p>        |
| <p><b>Module – III</b></p> <p>Overview of Independent Component Analysis, ICA and Kolmogoroff complexity, ICA by maximization of non-gaussianity, Non-gaussian is independent, measuring non-gaussianity by kurtosis, Measuring non-gaussianity by Negentropy, Gradient algorithm using Negentropy, ICA by maximum</p>  | <p><b>12</b></p>       |

|   |          |
|---|----------|
| likelihood Estimation, The likelihood of the ICA model, Algorithms for maximum likelihood Estimation, The Bell-Sejnowski Algorithm, The INFOMAX Principle,                  |          |
| <b>Module – IV</b><br><br>Sparse Representation, Sparse Signal Processing, Canonical Correlation Analysis, Empirical Mode Decomposition, and Vibrational Mode Decomposition | <b>6</b> |
| <b>Module – V</b><br><br>Spatial filters, Common Spatial Pattern, Application of CSP, BSS for practical Application and its Ambiguity                                       | <b>6</b> |

**Text Books:**

1. Independent Component Analysis by Aapo Hyvarinen, Juha Karhunen, Erkki Oja A Wiley-Interscience Publication, JOHN WILEY & SONS, INC. New York.
2. Adaptive Blind Signal and Image Processing Learning Algorithms and Applications, Andrzej Cichocki and Shun-ichi Amari, JOHN WILEY & SONS Ltd.

**Reference Book:**

1. EEG Signal Processing by Saied Sanei and J.A. Chambers. [John Wiley and Sons Ltd.
2. Toward Brain-Computer Interfacing by, Guido Dornhege, Jos´e del R. Mill´an Thilo Hinterberger, Dennis J. McFarland, Klaus-Robert M´uller. The MIT Press Cambridge, Massachusetts London, England

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

Multi-Channel Signal Processing is an advance course; hence it only lays down the foundation of multichannel biomedical signal processing, pattern recognition and classification problem.

**POs met through Gaps in the Syllabus**

May be met through laboratory simulations, experiments, and design problems.

**Topics beyond syllabus/Advanced topics/Design**

5. Application of Multi-Channel Signal Processing helps to analyze the multi-channel biomedical signal.
6. Extraction of Pattern vector from independent components for the development of decision support system for various applications.

**POs met through Topics beyond syllabus/Advanced topics/Design**

Assignments & Seminars

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| <b>Assessment Tool</b>   | <b>% Contribution during CO Assessment</b> |
|--------------------------|--|
| First Quiz               | 10   |
| Mid Semester Examination | 25   |
| Second Quiz              | 10   |
| Teacher's Assessment     | 5  |
| End Semester Examination | 50   |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  |                                  |    |    |
| CO2            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  |                                  |    |    |
| CO3            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 3 | 3 | 3  | 3  | 3  |                                  |    |    |
| CO4            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  |                                  |    |    |
| CO5            | 1                      | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1  |    | 1  |                                  |    |    |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Mapping between COs and Course Delivery (CD) methods**

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used        |
|---------|---|----------------|------------------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD2, CD5, CD8                 |
| CD2     | Tutorials/Assignments                   | CO2            | CD1, CD2, CD5, CD8                 |
| CD3     | Seminars                                | CO3            | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD4     | Mini Projects/Projects                  | CO4            | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |

|     |   |     |                    |
|-----|---|-----|--------------------|
| CD5 | Laboratory Experiments/Teaching Aids                        | CO5 | CD4, CD5, CD7, CD9 |
| CD6 | Industrial/Guest Lectures                                   |     |                    |
| CD7 | Industrial Visits/In-plant Training                         |     |                    |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |     |                    |
| CD9 | Simulation  |     |                    |

**COURSE INFORMATION SHEET**

**Course code:** EC 409

**Course title:** Fiber Optic Sensors

**Pre-requisite(s):** Knowledge of Semiconductor Devices, Basics of optical fibers **Co-requisite(s):** None



**Credits:** L: 3 T: 0 P: 0

**Class schedule per week:** 03

**Class:** B. Tech

**Semester / Level:** VII/ 4

**Branch:** ECE Name  
**of Teacher:**

### Course Objectives

This course enables the students:

|    |   |
|----|---|
| 1. | To understand the sensing principle of fiber optic sensors  |
| 2. | To understand the key characteristics of interferometric fiber optic sensors.   |
| 3. | To understand the key properties of quasi distributed grating based and fully distributed scattering based fiber optic sensors. |
| 4. | To understand practical applications of the optical fiber sensing technology.   |

### Course Outcomes

After the completion of this course, students will be able to:

|      |   |
|------|---|
| CO1. | Explain the key properties of fiber optic sensors.                              |
| CO2. | Explain the operational characteristics of interferometric fiber optic sensors. |
| CO3. | Design and develop the quasi distributed fiber optic sensors.                   |
| CO4. | Design and develop the fully distributed fiber optic sensors                    |
| CO5. | Apply the fiber optic sensors for particular applications.                      |

## Syllabus

| Module   | No. of lecture hours |
|--|----------------------|
| <b>Module - 1:</b><br>Basic Concept of fiber sensors, Classification of fiber sensors, Intensity modulated fiber sensors, Extrinsic and Intrinsic sensors, Phase modulated fiber sensors, Wavelength modulated fiber sensors, Polarization based sensors, Biophotonic sensors.                       | 8                    |
| <b>Module - 2:</b><br>Interferometric Fiber sensors, Mach-Zehnder Fiber sensor, Michelson interferometric fiber sensor, Fabry-Perot interferometric sensors (IFFPI, EFFPI), Sagnac interferometer, Low coherence interferometric sensor, Signal Recovering and noise source in fiber interferometry. | 7                    |
| <b>Module – 3:</b><br>Fiber Bragg Grating(FBG) theory and Fabrication, FBG sensing principles, Distributed FBG sensor, FBG Interrogation systems, Edge filter techniques, Active tunable filter techniques, Interrogation Using Mach–Zehnder Interferometer, FBG sensor multiplexing techniques.     | 9                    |
| <b>Module – 4:</b><br>Scattering based distributed fiber sensors, OTDR, Rayleigh scattering based OTDR sensor, Raman scattering based OTDR sensor, Brillouin scattering based OTDR sensor, Magnetic and electric field sensors, Intrinsic biophotonic sensors, Extrinsic biophotonic sensors.        | 9                    |
| <b>Module - 5:</b><br>Applications of fiber optic sensors in large concrete and smart structures, Load Monitoring of Power Transmission Lines, Medicine, Chemical sensing, Fiber sensors in Oil and Gas Industry, Applications in nuclear power industry.  | 7                    |

### Text books:

- T1. “Optical Fiber Sensors; Advanced Techniques and Applications” Ginu Rajan and Krzysztof Iniewski, CRC Press.
- T2. “Fiber Optic Sensors; fundamentals and Applications”, David A Krohn, SPIE Press.
- T3. “HANDBOOK OF OPTICAL FIBRE SENSING TECHNOLOGY” Jose Miguel Lopez-Higuera, JOHN WILEY & SONS, LTD

**Ref. Books:**

R1. "FIBER OPTIC SENSORS; An Introduction for Engineers and Scientists", ERIC UDD WILLIAM B. SPILLMAN,

JR., John Wiley & Sons

R2. "Fiber Optic Sensors, ", S Yin, P Rufin, F T S Yu, CRC Press.

**Gaps in the syllabus (to meet Industry/Profession requirements)**

**POs met through Gaps in the Syllabus**

**Topics beyond syllabus/Advanced topics/Design:**

**POs met through Topics beyond syllabus/Advanced topics/Design**

**Course Delivery Methods**

|     |   |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors      |
| CD2 | Assignments   |
| CD3 | Laboratory experiments/teaching aids/Seminars               |
| CD4 | Industrial/guest lectures                                   |
| CD5 | Industrial visits/in-plant training                         |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation  |

**Course Outcome (CO) Attainment Assessment tools & Evaluation procedure**

**Direct Assessment**

| Assessment Tool | % Contribution during CO Assessment |
|-----------------|-------------------------------------|
|-----------------|-------------------------------------|

|                          |    |
|--------------------------|----|
| First Quiz               | 10 |
| Mid Semester Examination | 25 |
| Second Quiz              | 10 |
| Teacher's Assessment     | 5  |
| End Semester Examination | 50 |

**Indirect Assessment –**

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

**Mapping of Course Outcomes onto Program Outcomes**

| Course     | Program Outcomes |   |   |   |   |   |   |   |   |    |    |    | Program Specific |    |    |
|------------|------------------|---|---|---|---|---|---|---|---|----|----|----|------------------|----|----|
|            | 1                | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13               | 14 | 15 |
| <b>CO1</b> | 3                | 3 | 2 | 2 | 2 | 1 | 2 |   | 1 | 2  | 1  | 1  | 3                | 2  | 2  |
| <b>CO2</b> | 3                | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 1 | 2  | 2  | 2  | 3                | 2  | 2  |
| <b>CO3</b> | 3                | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 1 | 2  | 2  | 2  | 2                | 3  | 2  |
| <b>CO4</b> | 3                | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 3  | 2  | 3  | 2                | 3  | 2  |

|     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO5 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 3 |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

**Correlation Levels 1, 2 or 3 as defined below:**

1: Low 2: Medium 3: High

**Mapping between Course Outcomes and Course Delivery Method**

| Course Outcomes | Course Delivery Method  |
|-----------------|-------------------------|
| CO1             | CD1, CD2, CD3, CD6, CD7 |
| CO2             | CD1, CD2, CD3, CD6, CD7 |
| CO3             | CD1, CD2, CD3, CD6, CD7 |
| CO4             | CD1, CD2, CD3, CD6, CD7 |
| CO5             | CD1, CD2, CD3, CD6, CD7 |

**COURSE INFORMATION SHEET**

**Course code: EC411**

**Course title: Mixed Signal Design**

**Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering, EC201**

**Electronic Devices Co- requisite(s):**

**Credits: L: 3 T: 0 P: 0 C: 3**

**Class schedule per week: 03 Class:**

B. Tech.

**Semester / Level: VII/04**

**Branch: ECE Name**

**of Teacher:**

## Course Objectives

This course enables the students to:

|    |  |
|----|--|
| 1. | Understand the basics of sampling theory.  |
| 2. | Interpret the Mixed-Signal Design Trends and Challenges and apply the perceived knowledge. |
| 3. | Appraise and analyse the analog filters.   |
| 4. | Design and Evaluate the characteristics of discrete time filters.                          |
| 5. | Create/develop the data converters.  |

## Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Describe and illustrate the basics of Analog and Discrete Time Signals   |
| CO2 | Sketch and explain the mixed-signal design trends and challenges.  |
| CO3 | Diagram and explain the analog.  |
| CO4 | Design, diagram and explain discrete time filters.   |
| CO5 | Design and schematize different types of data converters, schematize their characteristics and prepare an inference. |

## SYLLABUS

| MODULE | (NO. OF LECTURE HOURS) |
|--------|------------------------|
|--------|------------------------|

|   |                 |
|---|-----------------|
| <p><b>Module – I</b></p> <p>Basics Sampling and Aliasing:<br/> Sampling: Impulse Sampling, Decimation, The Sample-and-Hold (S/H), The Track-and-Hold (T/H), Switched-Capacitor Circuits, Non-Overlapping Clock Generation, Circuits: Implementing the S/H. Performance of sample-and-hold circuits, MOS sample-and-hold basics, examples of CMOS S/H circuit.</p>   | <p><b>8</b></p> |
| <p><b>Module – II</b></p> <p>Mixed-Signal Design Trends and Challenges:<br/> Design flow: Top-down design, Bottom-up Design, Constraint Management, Mixed-Signal Verification, Behavioral Modeling, Mixed-Signal Hardware Description Languages, Low Power Verification, Design for Test, Mixed-Signal layout &amp; Chip Planning, Interconnects and data transmission, Substrate Noise, AMS IP Reuse, Full-chip Signoff, IC/Package Co-Design.</p> | <p><b>8</b></p> |
| <p><b>Module – III</b></p>  | <p><b>8</b></p> |
| <p>Analog Filters:<br/> Integrator Building Blocks: Low pass Filters, Active-RC Integrators, MOSFETC Integrators, gm-C (Transconductor-C) Integrators, A High-Frequency Transconductor, Filtering Topologies.</p>   |                 |

|   |                 |
|---|-----------------|
| <p><b>Module – IV</b></p> <p>Digital Filters:<br/>Sinc-Shaped Digital Filters: The Counter, Low pass Sinc Filters, Bandpass and Highpass Sinc Filters, Interpolation using Sinc Filters, Decimation using Sinc Filters, Filtering Topologies: FIR Filters, Stability and Overflow, The Bilinear Transfer Function, The Canonic Form (or Standard Form) of a Digital Filter.</p> | <p><b>8</b></p> |
| <p><b>Module – V</b></p> <p>Data Converters:<br/>Basics of Analog to digital converters (ADC), Basics of Digital to analog converters (DAC), ADCs: Successive approximation ADCs, Dual slope ADCs, Flash ADC, Delta-sigma ADC, DACs: Resistor string, R-2R Ladder networks, Current steering, Charge scaling DACs, Cyclic DAC, Pipelined DACs.</p>                              | <p><b>8</b></p> |

**Textbooks:**

5. CMOS mixed-signal circuit design by R. Jacob Baker, Wiley India, IEEE press, reprint 2008.
6. CMOS circuit design, layout and simulation by R. Jacob Baker, Revised second edition, IEEE press, 2008.
7. Design of analog CMOS integrated circuits by Behzad Razavi, McGraw-Hill, 2003.
8. Mixed-Signal Methodology Guide, by Jess Chen et al., First Edition, September 11, 2014.
9. Tony Chan Carusone, David A. Johns and Kenneth W. Martin, Analogue Integrated Circuit Design, 2/e, John Wiley & Sons, 2012.

**Reference books:**

1. CMOS Integrated ADCs and DACs by Rudy V. dePlassche, Springer, Indian edition, 2005.
2. Electronic Filter Design Handbook by Arthur B. Williams, McGraw-Hill, 1981.



3. Design of analog filters by R. Schauman, Prentice-Hall 1990 (or newer additions).
4. An introduction to mixed-signal IC test and measurement by M. Burns et al., Oxford university press, first Indian edition, 2008.

**Gaps in the syllabus (to meet Industry/Profession requirements):**

1. Hands-on-practical for CMOS IC (Integrated Circuit) fabrication.

**POs met through Gaps in the Syllabus:**

10

**Topics beyond syllabus/Advanced topics/Design:**

1. RF circuits.

**POs met through Topics beyond syllabus/Advanced topics/Design:**

10

**Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 2                      | 2 | 2 | 1 |   |   | 1 |   | 1 | 2  | 1  | 2  | 2                                | 2  | 1  |
| CO2            | 3                      | 3 | 3 | 3 | 1 | 2 | 1 |   | 3 | 2  | 2  | 3  | 3                                | 3  | 1  |
| CO3            | 3                      | 3 | 3 | 3 | 1 | 2 | 1 |   | 3 | 2  | 2  | 3  | 3                                | 3  | 1  |
| CO4            | 2                      | 3 | 2 | 1 |   | 1 | 1 |   | 3 | 1  | 2  | 2  | 3                                | 2  | 1  |
| CO5            | 3                      | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 1  |    | 2  | 3                                | 2  | 1  |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD7, CD 8              |
| CD2     | Tutorials/Assignments                   | CO2            | CD1 and CD9                 |
| CD3     | Seminars                                | CO3            | CD1, CD2 and CD3            |
| CD4     | Mini Projects/Projects                  | CO4            | CD1 and CD2                 |
| CD5     | Laboratory Experiments/Teaching Aids    | CO5            | CD1 and CD2                 |
| CD6     | Industrial/Guest Lectures               |                |                             |
| CD7     | Industrial Visits/In-plant Training     |                |                             |

|     |   |  |  |
|-----|---|--|--|
| CD8 | Self- learning such as use of NPTEL Materials and Internets |  |  |
| CD9 | Simulation  |  |  |

### COURSE INFORMATION SHEET

**Course Code: EC413**

**Course Title: Real Time Embedded System**

**Pre-requisite(s): Fundamental knowledge of VLSI Design, Digital Electronics, Signal Processing, Communication Systems Co-requisite(s):**

**Credits:** L: 3 T: 0 P: 0

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: VII**

**Branch: Electronics & Communication Engineering Name of Teacher:**

### **Course Objectives**

This course envisions imparting to students to:

|    |  |
|----|--|
| 1. | Define the fundamental of embedded systems   |
| 2. | Show the correlation between hardware & software in embedded system                |
| 3. | Develop the suitable software for embedded system as per demand of present market. |
| 4. | Design the highly secure optimized embedded systems                                |
| 5. | Develop the tool and techniques for the development of real time system            |

### **Course Outcomes**

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Recognize the interfacing and integration of component in SoC.          |
| CO2 | Design the highly secure ATM.   |
| CO3 | Develop the programmable kit to check the entire components in a board. |

|     |  |
|-----|--|
| CO4 | Develop the embedded systems & corresponding software as per demand of current market. |
| CO5 | Demonstrate the tool and techniques for the development of real time system            |

## SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <p><b>Module – I</b><br/> <b>Custom Input/Output Interfacing with VHDL and FPGA kit::</b></p> <p>Optical Display Interfacing, Buzzer Control, Liquid Crystal Display Interfacing, General-Purpose Switch Interfacing, Optical Sensor Interfacing,</p>                    | <b>9</b>               |
| <p>Module – II<br/> <b>Interfacing Digital Logic to the Real World with VHDL and FPGA kit:</b></p> <p>Basics of Signal Conditioning for Sensor Interfacing, Principles of Sensor Interfacing and Measurement Techniques, Multichannel Data Logging.</p>                  | <b>7</b>               |
| <p><b>Module – III</b><br/> <b>Real-World Control Device Interfacing with VHDL and FPGA kit:</b></p> <p>Relay, Solenoid Valve, Opto-Isolator, and Direct Current Motor Interfacing and Control, Servo and BLDC Motor Interfacing and Control, Stepper Motor Control.</p> | <b>8</b>               |
| <p><b>Module – IV</b><br/> <b>Introduction to IoT:</b></p> <p>What is the Internet of Things (IoT)? Potential IoT Applications, IoT Enabling Technologies: Sensors and Actuators, RFID and NFC (NearField Communication), LiFi, ZigBee.</p>                              | <b>8</b>               |

|  |          |
|--|----------|
| <b>Module – V</b><br><br><b>Application of IoT:</b><br><br>Digital Inputs and Outputs, Analog Inputs and Outputs, Accelerometer and Magnetometer, Digital Interfaces, Networking and Communications. | <b>8</b> |
|--|----------|

**Textbooks:**

1. A. Arockia Bazil Raj, “FPGA based embedded system developer's guide”, Taylor & Francis, CRC Press, 2018.
2. Perry Xiao, “Designing Embedded Systems and the Internet of Things (IoT) with the ARM Mbed”, John Wiley & Sons Ltd., 2018.

**Reference Books:**

1. Ronald Sass, Andrew G. Schmidt, “Embedded Systems Design with Platform FPGAs - Principles and Practices, Morgan Kaufmann Publishers, 2010.
2. Peter Marwedel, “Embedded System Design: Embedded System, Foundations of CyberPhysical Systems, and the internet of Things”, 3<sup>rd</sup> edition, Springer International, 2018.

**Gaps in the syllabus (to meet Industry/Profession requirements):** N/A

**POs met through Gaps in the Syllabus:** PO8 will be met though report writing/presentationbased assignment

**Topics beyond syllabus/Advanced topics/Design:** Teaching through latest research paper

**POs met through Topics beyond syllabus/Advanced topics/Design:** Teaching through paper

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |

|                          |    |
|--------------------------|----|
| Second Quiz              | 10 |
| Teacher's Assessment     | 5  |
| End Semester Examination | 50 |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2  | 3  | 2  | 2                                | 2  | 3  |
| CO2            | 3                      | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3  | 3  | 2  | 2                                | 2  | 3  |
| CO3            | 3                      | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2  | 2  | 2  | 3                                | 3  | 3  |
| CO4            | 3                      | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3  | 2  | 2  | 3                                | 3  | 3  |
| CO5            | 3                      | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2  | 3  | 2  | 3                                | 3  | 3  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD7, CD8               |
| CD2     | Tutorials/Assignments                   | CO2            | CD1 and CD9                 |
| CD3     | Seminars                                | CO3            | CD1, CD2 ,CD3               |

|     |   |     |             |
|-----|---|-----|-------------|
| CD4 | Mini Projects/Projects                                      | CO4 | CD1 and CD2 |
| CD5 | Laboratory Experiments/Teaching Aids                        | CO5 | CD1 and CD2 |
| CD6 | Industrial/Guest Lectures                                   |     |             |
| CD7 | Industrial Visits/In-plant Training                         |     |             |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |     |             |
| CD9 | Simulation  |     |             |

### **COURSE INFORMATION SHEET**

**Course Code: EC414**

**Course Title: Real Time Embedded System Design Lab**

**Pre-requisite(s): Fundamental knowledge of VLSI Design, Digital Electronics Co-requisite(s):**

**Credits:** L: 0 T: 0 P: 3

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: VII**

**Branch: Electronics & Communication Engineering Name of Teacher:**

#### **Course Objectives**

This course envisions imparting to students to:

|    |   |
|----|---|
| 1. | Recognize the programmable hardware and its programming.                            |
| 2. | Develop an ability to write 8051based assembly language/ C programs.                |
| 3. | Write the program for different-2 on-chip peripherals to work with Microcontroller. |

|    |  |
|----|--|
| 4. | Develop industrial potentials to develop product in prototype as per demand of market. |
| 5. | Develop the tools and techniques for complex chip design & debugging                   |

### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Recognize the concept of programmable hardware and its programming.  |
| CO2 | Recognize to write 8051based assembly language/ C programs.  |
| CO3 | Write the efficient program for various on-chip peripherals to work with Microcontroller.  |
| CO4 | Develop industrial competency to develop product in prototype as per demand of market and capability to debug the complex chip problems. |
| CO5 | Demonstrate the tool and techniques for the design & debugging the complex chip  |

### List of Experiments

1. Design a 2-bit adder using System Generator on Xilinx ISE 10.1i. Synthesize the circuit, download the configuration file to the prototyping board (use Spartan-3E Starter kit) and verify its operation with Chip Scope Pro.
2. Design a 4-bit Johnson counter using Verilog on Xilinx ISE 10.1i. Synthesize the circuit, download the configuration file to the prototyping board (use Xilinx XC9572 CPLD in Milman VLSI Trainer kit) and verify its operation.
3. Design a circuit to implement GCD (greatest common divisor) algorithm using Verilog on Xilinx ISE 8.1i. Synthesize the circuit, download the configuration file to the prototyping board (use Spartan-3E Starter kit) and verify its operation.
4. Develop a digital system to display “DIAT” on a multi-segment LED display panel. The scrolling of the word has to be in the right-to-left direction. Assume each segment of the LED display panel has eight rows and eight columns.
5. Develop a digital system to display digital pulses on pages 1 and 6 of a GLCD. Use both segments and display two cycles in each page. Use the onboard DIP switch for resetting the GLCD.
6. Outline and write a VHDL/Verilog code for designing a 2-bit adder using System Generator. Test your VHDL/Verilog code by simulating it, find error, if any; synthesize the error free RTL code; experiment your design downloading the configuration file into the Xilinx XC9572 CPLD in Milman VLSI Trainer kit /Spartan-3E Starter kit and verify its operation without Chip Scope Pro.
7. Sixteen LEDs are connected to the FPGA in common cathode configuration. Develop VHDL/Verilog code to make the first eight LEDs glow in a downward direction while the



- other eight LEDs glow in an upward direction. This has to happen five times; then all the LEDs have to blink two times. Simulate your VHDL/Verilog code, find error, if any; synthesize the error free RTL code; experiment your design downloading the configuration file into the Xilinx XC9572 CPLD in Milman VLSI Trainer kit and show the results.
8. Develop a digital system in FPGA to drive a buzzer at different duty cycles 0%, 40%, 80%, and 100% whenever the input (data\_in) is ( $0 \leq \text{data\_in} \leq 10$ ), ( $10 < \text{data\_in} \leq 100$ ), ( $100 < \text{data\_in} \leq 200$ ) and ( $200 < \text{data\_in}$ ), respectively. Assume that the inputs are given via a port of eight bits. Simulate your VHDL/Verilog code, find error, if any; synthesize the error free RTL code; experiment your design downloading the configuration file into the Xilinx XC9572 CPLD in Milman VLSI Trainer kit and show the results.
  9. Develop a digital system in the FPGA to control appliances from a remote station using DTMF (Dual-Tone Multifrequency Decoder) tones as per the following requirements.
    - a) There are nine electrical appliances that have to be controlled.
    - b) DTMF tone “0” has to be used to switch off all the appliances.
    - c) DTMF tone data (1–9) have to be used to select a particular appliance.
    - d) “\*” and “#”, that is, A (“1010”) and C (“1100”), have to be used to switch the appliances “on” and “off”, respectively.
  10. Develop a FPGA-based digital system to continuously monitor and automatically fill the chemical fluid in a tank. A proximity sensor is placed inside the tank so as to get IR radiation reflected back to the phototransistor from the chemical fluid surface. The output of the phototransistor is given to an 8-bit A/D convertor. Hence, the fluid level is measured by A/D and given to the FPGA via 8-bit data. The system has to indicate the fluid level in the first row of an LCD and switch on the fluid inlet motor if the level goes below “00001111”.
  11. Write a program to read two digital inputs from pins D6 and D7, performs the logical AND, and sets it to D9 pin for output.
  12. Write a program to read the analog input from pin A0, multiply it by 10, and set it to the analog output pin DAC0\_OUT for output.

### Optional Experiments

13. Write a program, so that it can create a sine wave on the analog output pin DAC0\_OUT pin.
14. Write a program to read both the accelerometer and the magnetometer values.
15. Write program to read lowercase characters from a computer serial port, convert them to uppercase, and echo them back.
16. Write a program read three integer numbers from computer serial port; numbers are separated by “ , ”.
17. Write a program to read characters from a computer serial port, send them to the device serial interface (D4, D5), and vice versa.
18. Write a program so that one FRDM-K64F board can communicate with another FRDMK64F board (or LPC1768 board) through a serial interface (D4, D5).
19. Write two programs so that the SPI server can read the digital input pin D0 and send a value to SPI clients.
20. Write two programs so that the I2C server can send 10 data to I2C clients.

21. Write a program to read the analog pin A0, and sends the value to CAN1 (Controller Area Network).
22. Write a program to read the analog inputs A0, A1, A2 and display the values as a table in HTTP body message.
23. Write TCP client/server programs so that the server receives the message from the client, changes it to uppercase, then echoes it back to the client.
24. Write UDP client/server programs so that the server reads the digital pin D0 and sends the value to the client.
25. Write a program to continuously read the temperature sensor values and send it to the WebSocket server.

### **Textbooks:**

3. A. Arockia Bazil Raj, "FPGA based embedded system developer's guide", Taylor & Francis, CRC Press, 2018.
4. Perry Xiao, "Designing Embedded Systems and the Internet of Things (IoT) with the ARM Mbed", John Wiley & Sons Ltd., 2018.

### **Reference Books:**

3. Ronald Sass, Andrew G. Schmidt, "Embedded Systems Design with Platform FPGAs - Principles and Practices, Morgan Kaufmann Publishers, 2010.
4. Peter Marwedel, "Embedded System Design: Embedded System, Foundations of CyberPhysical Systems, and the internet of Things", 3<sup>rd</sup> edition, Springer International, 2018.

**Gaps in the syllabus (to meet Industry/Profession requirements):** N/A

**POs met through Gaps in the Syllabus:** PO8 will be met through report writing/presentation based assignment

### **Topics beyond syllabus/Advanced topics/Design:**

1. Teaching through latest research paper

### **POs met through Topics beyond syllabus/Advanced topics/Design:**

1. Teaching through paper

### **Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

## Direct Assessment

| Assessment Tool        | % Contribution during CO Assessment |
|------------------------|-------------------------------------|
| Progressive Evaluation | 60                                  |
| End Sem Evaluation     | 40                                  |

## Indirect Assessment

1. Students' Feedback on Course Outcome.

## Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2  | 3  | 2  | 3                                | 3  | 3  |
| CO2            | 3                      | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3  | 3  | 2  | 3                                | 3  | 2  |
| CO3            | 3                      | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2  | 2  | 2  | 3                                | 3  | 3  |
| CO4            | 3                      | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3  | 2  | 2  | 3                                | 3  | 1  |
| CO5            | 3                      | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2  | 3  | 2  | 3                                | 3  | 3  |

## Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

## Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD7, CD8               |
| CD2     | Tutorials/Assignments                   | CO2            | CD1 and CD9                 |

|     |   |     |             |
|-----|---|-----|-------------|
| CD3 | Seminars  | CO3 | CD1,CD2,CD3 |
| CD4 | Mini Projects/Projects                                      | CO4 | CD1 and CD2 |
| CD5 | Laboratory Experiments/Teaching Aids                        | CO5 | CD1 and CD2 |
| CD6 | Industrial/Guest Lectures                                   |     |             |
| CD7 | Industrial Visits/In-plant Training                         |     |             |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |     |             |
| CD9 | Simulation  |     |             |

### COURSE INFORMATION SHEET

**Course Code: EC415**

**Course Title: Semicustom IC Design**

**Pre-requisite(s):** Fundamental knowledge of VLSI Design, Digital Electronics, Fabrication Process & IC Technology, Embedded System Design, Coding of VHDL, Verilog, C/C++

**Co- requisite(s):** VHDL / Verilog **Credits:** L: 3 T: 0 P: 0

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: VII**

**Branch: Electronics & Communication Engineering Name of Teacher:**

## Course Objectives

This course envisions imparting to students to:

|    |  |
|----|--|
| 1. | Demonstrate the structure of semicustom integrated circuit, semicustom selection techniques, supplier & design route |
| 2. | Elaborate the circuit design techniques & logics design using ASM method   |
| 3. | Show the programmable logic array implementation and methodology, and demonstrate the PLA and ROM based design       |
| 4. | Explore the CAD and design automation and simulation techniques  |
| 5. | Demonstrate the partitioning, placement, automated layout & design for testability                                   |

## Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Show the structure of semicustom integrated circuit, semicustom selection techniques, supplier & design route     |
| CO2 | Illustrate the circuit design techniques & logics design using ASM method   |
| CO3 | Demonstrate the programmable logic array implementation and methodology, and explain the PLA and ROM based design |
| CO4 | Elaborate the CAD and design automation and simulation techniques   |
| CO5 | Demonstrate the partitioning, placement, automated layout & design for testability                                |

## SYLLABUS

| <b>MODULE</b> | <b>(NO. OF LECTURE HOURS)</b> |
|---------------|-------------------------------|
|               |                               |

|  |                 |
|--|-----------------|
| <p><b>Module – I</b></p> <p><b>Structure of semicustom integrated circuit, semicustom selection techniques, supplier &amp; design route:</b></p> <p>Introduction to semicustom integrated circuit, gate arrays, cell based systems, programmable logic devices, analogue component arrays, semicustom techniques, choice of semicustom techniques, choice of semicustom suppliers, choice of entry point and design route.</p>                     | <p><b>9</b></p> |
| <p><b>Module – II</b></p> <p><b>Circuit design techniques &amp; logics design using ASM method:</b></p> <p>Custom design, design techniques-BJT, design technique-MOS, design time scales, semicustom gate arrays &amp; cell based, ASM design approach, algorithm of solution, timing, external signals, controller description, state assignment.</p>  | <p><b>7</b></p> |
| <p><b>Module – III</b></p> <p><b>Programmable logic array implementation and methodology, PLA and ROM based design:</b></p> <p>Implementation of NMOS &amp; CMOS layout, the PLA as structure, cost performance improvement (multi level PLA's folding, performance) , finite state machine; state table, gate based design(random logic, multiplexers), programmable logic array(PLAs, FPLAs, logic PAL), extending and component capability.</p> | <p><b>8</b></p> |
| <p><b>Module – IV</b></p> <p><b>CAD and design automation and simulation techniques:</b></p> <p>Use of computer in design, benefits of CADs, CAD for semicustom ICs, placement, tracking or routing, test generation, input and CAE</p>  | <p><b>8</b></p> |
| <p>workstations, verification and simulations, timing verifications, cells and verifications, levels of simulations, a review of techniques employed in logic simulation.</p>  |                 |

|  |                 |
|--|-----------------|
| <p><b>Module – V</b></p> <p><b>Partitioning, placement, automated layout &amp; design for testability :</b></p> <p>Partitioning( regularity &amp; number of interconnects), auto layout( placement, routing, hierarchical routing, design of testability, test strategy requirements in VLSI design, partitioning for testability, self-test, built-in test, scan path, signature analysis, built-in logic block observation(BILBO), testability in semicustom circuits.</p> | <p><b>8</b></p> |
|--|-----------------|

**Text Books:**

- 1.P.J. Hicks, “Semicustom IC Design & VLSI”, Peter Peregrinus, Ltd, 1983.
- 2.Jack Ganssle, "The Art of Designing Embedded Systems", Newnes, 1999.

**Reference Books:**

1. M. Sarrafzadeh, “Introduction to VLSI Physical Design”, McGraw Hill (IE), 1996.
2. Recent literature in Physical Design Automation.

**Gaps in the syllabus (to meet Industry/Profession requirements):** N/A

**POs met through Gaps in the Syllabus:** PO8 will be met though report writing/presentationbased assignment

**Topics beyond syllabus/Advanced topics/Design:** Teaching through latest research paper

**POs met through Topics beyond syllabus/Advanced topics/Design:** Teaching through paper  
**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher’s Assessment     | 5                                   |

|                          |    |
|--------------------------|----|
| End Semester Examination | 50 |
|--------------------------|----|

## Indirect Assessment

### 1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2  | 3  | 2  | 3                                | 3  | 32 |
| CO2            | 3                      | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3  | 3  | 2  | 3                                | 3  | 2  |
| CO3            | 3                      | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2  | 2  | 2  | 3                                | 3  | 2  |
| CO4            | 3                      | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3  | 2  | 2  | 3                                | 3  | 1  |
| CO5            | 3                      | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2  | 3  | 2  | 3                                | 3  | 3  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|------|---|----------------|-----------------------------|
| CD1  | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD7, CD8               |



|     |   |     |                  |
|-----|---|-----|------------------|
| CD2 | Tutorials/Assignments                                       | CO2 | CD1 and CD9      |
| CD3 | Seminars  | CO3 | CD1, CD2 and CD3 |
| CD4 | Mini Projects/Projects                                      | CO4 | CD1 and CD2      |
| CD5 | Laboratory Experiments/Teaching Aids                        | CO5 | CD1 and CD2      |
| CD6 | Industrial/Guest Lectures                                   |     |                  |
| CD7 | Industrial Visits/In-plant Training                         |     |                  |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |     |                  |
| CD9 | Simulation  |     |                  |

**COURSE INFORMATION SHEET**  
**Satellite Communication**

**Course Code: EC419**

**Course Title: Satellite Communication**

**Pre-requisite(s):** ) Knowledge of Communication process, basic understanding of interference and noise in communication process, basic understanding of communication media.

**Co- requisite(s):**

**Credits:** L: 3 T: 0 P: 0 C:3

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: Sixth/Third**

**Branch: Electronics & Communication Engineering Name of Teacher:**

**Course Objectives**

This course envisions to impart to students to:

|    |   |
|----|---|
| 1. | An understanding on Satellite communication system  |
| 2. | An ability to evaluate the impact of interference on the satellite communication and complete link design.      |
| 3. | An ability to analyze different system parameters, causes of impairments in satellite communication system      |
| 4. | An understanding of Multiple access techniques to support satellite communication and special satellite systems |
| 5. | An understanding on Satellite system, satellite sub system and earth station.                                   |

**Course Outcomes**

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Demonstrate an understanding on orbital and functional principles of satellite Communication   |
| CO2 | Architect, Interpret and select appropriate technologies for implementation of specified satellite communication systems.                    |
| CO3 | Analyze and evaluate a satellite link and suggest enhancements to improve the link performance   |
| CO4 | Demonstrate an understanding of advancement and multiple access techniques to support satellite communication. And various satellite systems |
| CO5 | Demonstrate an understanding on Satellite system, Satellite sub system and Earth station system.   |

## SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b><br/> <b>An overview of satellite communication:</b><br/>           Satellite orbits, kepler’s law, Orbital Elements, Look Angles, Orbital perturbation, Coverage angle, slant range, Eclipse effect, Sun transit outage, Placement of a satellite in a geostationary orbit, Multistage rocket launchers and their Performance (trichy), Station keeping and Stabilization</p>  | <p><b>10</b></p>       |
| <p><b>Module – II</b><br/> <b>Basic transmission theory:</b><br/>           Friss transmission equation, EIRP, Completion Link design, System noise temperature G/T ratio, Noise figure and Noise temperature.</p>  | <p><b>7</b></p>        |
| <p><b>Module – III</b><br/> <b>Communication Satellite Sub-systems:</b><br/>           Space Platform (Bus) and Communication Subsystem (Payload), Satellite Antennas, Frequency reuse Antennas, Earth station antennas, Tracking, Equipment for earth stations, Equipment Reliability and Space qualification</p>  | <p><b>7</b></p>        |
| <p><b>Module – IV</b><br/> <b>Multiple Access Techniques:</b><br/>           Analog Satellite Communication Vs Digital Satellite Communication, Multiple Access Techniques, FDMA Concept, MCPC &amp; SCPC, TDMA frame efficiency and super frame structure, Frame Acquisition and Synchronisation, CDMA concept, PN system, Spread spectrum, DSSS, DS CDMA, FHSS, FH CDMA. Demand Assignment Multiple Access, Digital Speech Interpolation and SPADE.</p> | <p><b>10</b></p>       |
| <p><b>Module – V</b><br/> <b>Special Purpose Satellite:</b><br/>           INTELSAT, INMARSAT, Direct Broadcast Satellite, Very Small Aperture Terminal Networks, Mobile Satellite Networks and Global Positioning Satellite system</p>   | <p><b>6</b></p>        |

### Text Books:

1. T. Pratt & C. W. Bostian, Satellite Communication.
2. Tri T. Ha, Digital Satellite communication, McGraw Hill.

### Reference Books:

1. Dennis Roddy, Satellite Communication, McGraw Hill

### Gaps in the Syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design :

POs met through Topics beyond syllabus/Advanced topics/Design:

### Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:PO1

#### Direct Assessment

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

#### Indirect Assessment

1. Students' Feedback on Course Outcome.

#### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 1 | 1 | 2 | 1 | - | - | - | - | -  | -  | 2  | 3                                | 2  | 1  |
| CO2            | 3                      | 3 | 3 | 2 | 1 | - | - | - | - | -  | -  | 1  | 3                                | 2  | 2  |
| CO3            | 3                      | 3 | 2 | 2 | 2 | - | - | - | - | -  | -  | 1  | 3                                | 2  | 1  |
| CO4            | 3                      | 2 | 1 | 1 | 1 | - | - | - | - | -  | -  | 1  | 3                                | 2  | 3  |
| CO5            | 3                      | 1 | 1 | 2 | 1 | - | - | - | - | -  | -  | 2  | 3                                | 2  | 2  |

#### Correlation Levels 1, 2 or 3 as defined below:

- 1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD8                    |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1 ,CD8                    |
| CD3     | Seminars  | CO3            | CD1, CD8                    |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1, CD8                    |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD1,CD8                     |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9     | Simulation  |                |                             |

### COURSE INFORMATION SHEET

**Course code:** EC420

**Course title:** Advanced Communication Lab

**Pre-requisite(s):** Knowledge of analog and digital communication **Co-requisite(s):**

**Credits:** L: 0 T: 0 P: 3 C: 1.5 **Class**

**schedule per week:** 03 **Class: B. Tech.**

**Semester / Level:** Sixth/Three

**Branch:** Electronics & Communication Engineering

**Name of Teacher:** ALL

#### Course Objectives:

This course enables the students:

|     |   |
|-----|---|
| 26. | Find geographical position using survey plotting with the help of GPS system      |
| 27. | Configure different wireless communication systems and evaluate their functioning |
| 28. | Design micro strip patch antenna  |

|     |   |
|-----|---|
| 29. | Evaluate the impact of path loss and shadowing in estimation of received signal power |
| 30. | Configure ZigBee Module   |

### Course Outcomes:

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Find geographical position using survey plotting with the help of GPS system          |
| CO2 | Configure different wireless communication systems and evaluate their functioning     |
| CO3 | Design micro strip patch antenna  |
| CO4 | Evaluate the impact of path loss and shadowing in estimation of received signal power |
| CO5 | Have an ability to Configure ZigBee Module  |

### Syllabus

#### List of Compulsory experiments:

**1. Name of the Experiment: PN sequence**

AIM-1: Study the PN sequence and examine Gold code with variable sequence length and analyse its correlation. Also set up voice communication using DSSS scheme using CDMA trainer kit (ST-2131-A).

**2. Name of the Experiment: GPS satellite**

AIM-1: Set up a link between GPS satellite and GPS trainer kit (ST-2276), and measure the present position.

**3. Name of the Experiment: GPS Survey plotting.**

AIM-1: Using GPS system, study the graphical representation of geographical position using Survey plotting.

**4. Name of the Experiment: RFID system**

AIM-1: Study of RFID system and its applications.

**5. Name of the Experiment: ALOHA protocols**

AIM-1: Study of pure ALOHA and slotted ALOHA protocols for WLAN System.

**6. Name of the Experiment: ZigBee module**

AIM-1: Configure ZigBee module as an end device and, set up a communication link with two ZigBee modules.

**7. Name of the Experiment: GPRS system**

AIM-1: Study the GPRS system and use it for sending an e-mail through WI-GPRS trainer.

**8. Name of the Experiment: GSM AT commands**

AIM 1: Study the GSM modem and its different module for phone book, setting up a call, sending SMS and identifying call history using AT commands.

**9. Name of the Experiment: Interfacing of GSM modem** AIM 1: Interfacing of GSM modem with control unit.

**10. Name of the Experiment: LTE 2x2 MIMO system**

AIM 1: Setting up of LTE 2x2 MIMO system for establishing two way communication.

**11. Name of the Experiment:, Design of rectangular micro strip patch antenna using IE3D**

AIM 1: Using IE3D, design a rectangular micro strip patch antenna for inset feed for operating frequency of 1.88 GHz, relative permittivity of 4.4 and length of 31 mils.

**12. Name of the Experiment: Estimation of path loss and shadowing**

AIM 1: Evaluate the impact of path loss and shadowing in estimation of received signal power in mobile cellular communication using Virtual Lab for Fading Channels.

**Text Book:**

2. Vijay K. Garg, “Wireless Communications and Networks”, Morgan Kaufmann Publishers an Imprint of Elsevier, USA 2009 (Indian reprint).

**Reference Books:**

3. Simon Haykin, “Communication Systems”, Wiley Eastern Limited, New Delhi, 2016, 4/e.
4. J. Schiller, “Mobile Communication” 2/e, Pearson Education, 2012.

**Gaps in the syllabus (to meet Industry/Profession requirements): NA**

**POs met through Gaps in the Syllabus: N/A.**

**Topics beyond syllabus/Advanced topics/Design: N/A**

**POs met through Topics beyond syllabus/Advanced topics/Design: N/A**

**Course Outcome (CO) Attainment Assessment tools & Evaluation procedure**

**Direct Assessment**

| <b>Assessment Tool</b>        | <b>% Contribution during CO Assessment</b> |
|-------------------------------|--|
| <b>Progressive Evaluation</b> | <b>(60)</b>                                |
| Attendance Marks              | <b>12</b>                                  |
| Day-to-day performance Marks  | <b>06</b>                                  |
| Lab Viva marks                | <b>20</b>                                  |
| Lab file Marks                | <b>12</b>                                  |
| Lab Quiz-I Marks              | <b>10</b>                                  |
| <b>End SEM Evaluation</b>     | <b>(40)</b>                                |
| Lab Quiz-II Marks             | <b>10</b>                                  |
| Lab performance Marks         | <b>30</b>                                  |



**Indirect Assessment –**

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |   |   |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|---|---|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1                                | 2 | 3 |
| CO1            | 3                      | 3 | - | - | 3 | - | - | - | - | 3  | -  | 1  | 2                                | 2 | 1 |
| CO2            | 3                      | 3 | - | - | 3 | - | - | - | - | 3  | -  | 1  | 2                                | 2 | 1 |
| CO3            | 3                      | 3 | 3 | - | 3 | - | - | - | - | 3  | -  | 1  | 2                                | 2 | 1 |
| CO4            | 3                      | 3 | 1 | - | 3 | - | - | - | - | 3  | -  | 1  | 2                                | 2 | 1 |
| CO5            | 3                      | 3 | 3 | - | 3 | - | - | - | - | 3  | -  | 1  | 2                                | 2 | 1 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods:**

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD5, CD9               |
| CD2     | Tutorials/Assignments                   | CO2            | CD1, CD5, CD9               |

|     |   |     |               |
|-----|---|-----|---------------|
| CD3 | Seminars/ Quiz (s)  | CO3 | CD1, CD5, CD9 |
| CD4 | Mini Projects/Projects                                      | CO4 | CD1, CD5      |
| CD5 | Laboratory Experiments/Teaching Aids                        | CO5 | CD1, CD5      |
| CD6 | Industrial/Guest Lectures                                   |     |               |
| CD7 | Industrial Visits/In-plant Training                         |     |               |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |     |               |
| CD9 | Simulation  |     |               |

### **COURSE INFORMATION SHEET**

**Course Code:** EC421

**Course Title:** Bio-Medical Electronics & Signal Processing

**Pre-requisite(s):** Signal Processing Techniques, Time Frequency and Wavelet Transform, Probability and Random Processes, Multichannel Signal Processing **Co- requisite(s):**

**Credits:** L: 3 T: 0 P: 0

**Class schedule per week:** 03 Class:

**B. Tech.**

**Semester / Level:** VII

**Branch:** Electronics and Communication Engineering Name  
**of Teacher:**

#### **Course Objectives**

This course envisions to impart to students to:

|     |   |
|-----|---|
| 36. | Understand the fundamentals of Digital Signal Processing and Biomedical Signal Processing.  |
| 37. | Grasp the concept of stochastic processes to develop advanced Biomedical signal processing concept.   |
| 38. | Comprehend Digital Signal Processing and Biomedical Signal Processing.  |
| 39. | Grasp how to integrate the concept of matrix algebra, probability models, random processes and linear algebra to Separate information Source using Spatial filters. |
| 40. | To develop and ability to evaluate the performance of BSS algorithm in diverse areas of application with the help of practical examples.                            |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Distinguish Digital Signal Processing and Biomedical Signal Processing.   |
| CO2 | Use the concept of stochastic processes to develop advanced Biomedical signal processing concept.   |
| CO3 | Analyse Biomedical signals using PCA, BSS and ICA to separate or decorrelate the Multichannel Biomedical Signal.  |
| CO4 | Integrate the concept of matrix algebra, probability models, random processes and linear algebra to develop Spatial filters for pattern classification. |
| CO5 | Apply the BSS algorithm as preprocessing method before feature extraction over real time signals  |

## SYLLABUS

| <b>MODULE</b>   | <b>(NO. OF LECTURE HOURS)</b> |
|---|-------------------------------|
| <b>Module – I</b><br>Acquisition, Generation of Bio-signals, Origin of bio-signals, Types of biosignals, Study of diagnostically significant bio-signal parameters, Electrodes for bio-physiological sensing and conditioning, Electrode-electrolyte interface, polarization, electrode skin interface and motion artefact, biomaterial used for electrode, Types of electrodes (body surface, internal, array of electrodes, microelectrodes), Practical aspects of using electrodes, Acquisition of bio-signals (signal conditioning) and Signal conversion (ADC's DAC's) Processing, Digital filtering | <b>12</b>                     |
| <b>Module – II</b><br>Biomedical signal processing by Fourier analysis, Bio-Medical signal processing by wavelet (time frequency) analysis, Analysis (Computation of signal parameters that are diagnostically significant)   | <b>9</b>                      |
| <b>Module – III</b><br>Classification of signals and noise, Spectral analysis of deterministic, stationary random signals and non-stationary signals, Coherent treatment of various biomedical signal processing methods and applications.  | <b>8</b>                      |

|  |                 |
|--|-----------------|
| <p><b>Module – IV</b></p> <p>Principal component analysis, Correlation and regression, Analysis of chaotic signals Application areas of Bio–Signals analysis Multiresolution analysis (MRA) and wavelets, Principal component analysis (PCA), Independent component analysis (ICA)</p> | <p><b>6</b></p> |
| <p><b>Module – V</b></p> <p>Pattern classification–supervised and unsupervised classification, Neural networks, Support vector Machines, Hidden Markov models. Examples of biomedical signal classification examples</p>   | <p><b>6</b></p> |

**References:**

1. W. J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall, 1993.
2. Eugene N Bruce, "Biomedical Signal Processing and Signal Modeling", John Wiley & Son's \_publication, 2001.

**Reference Book:**

1. Myer Kutz, "Biomedical Engineering and Design Handbook, Volume I", McGraw Hill, 2009.\_
2. D C Reddy, "Biomedical Signal Processing", McGraw Hill, 2005.
3. Katarzyn J. Blinowska, JaroslawZygierewicz, "Practical Biomedical Signal Analysis Using MATLAB", 1st Edition, CRC Press, 2011.

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

Multi-Channel Signal Processing is an advance course; hence it only lays down the foundation of multichannel biomedical signal processing, pattern recognition and classification problem.

**POs met through Gaps in the Syllabus**

May be met through laboratory simulations, experiments, and design problems.

**Topics beyond syllabus/Advanced topics/Design**

7. Application of Multi-Channel Signal Processing helps to analyze the multi-channel biomedical signal.
8. Extraction of Pattern vector from independent components for the development of decision support system for various applications.

**POs met through Topics beyond syllabus/Advanced topics/Design**

Assignments & Seminars

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure****Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  | 3                                | 3  | 2  |
| CO2            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  | 3                                | 3  | 2  |
| CO3            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 3 | 3 | 3  | 3  | 3  | 3                                | 3  | 2  |
| CO4            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  | 3                                | 3  | 2  |
| CO5            | 1                      | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1  |    | 1  | 1                                | 1  | 1  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

### Mapping between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD2, CD5, CD8          |
| CD2     | Tutorials/Assignments                   | CO2            | CD1, CD2, CD5, CD8          |

|     |   |     |                                    |
|-----|---|-----|------------------------------------|
| CD3 | Seminars  | CO3 | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD4 | Mini Projects/Projects                                      | CO4 | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD5 | Laboratory Experiments/Teaching Aids                        | CO5 | CD4, CD5, CD7, CD9                 |
| CD6 | Industrial/Guest Lectures                                   |     |                                    |
| CD7 | Industrial Visits/In-plant Training                         |     |                                    |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |     |                                    |
| CD9 | Simulation  |     |                                    |



## COURSE INFORMATION SHEET

Course code: **EC422**

Course title: Bio-Medical Signal Processing Lab Pre-requisite(s):

**EC305 Signal Processing Techniques**

Co- requisite(s):

Credits: L: 3 T: 0 P: 0

Class schedule per week: 03

Class: B. Tech.

Semester / Level: 7

Branch: ECE

Name of Teacher:

### Course Objectives:

This course enables the students to:

|    |  |
|----|--|
| 1. | Understand the fundamentals of Signal Processing and Multi-channel Signal Processing.  |
| 2. | Grasp the concept of stochastic processes to develop advanced signal processing concept.   |
| 3. | Comprehend Signal Processing and Multichannel Signal Processing.   |
| 4. | Grasp how to integrate the concept of matrix algebra, probability models, random processes and linear algebra to Advance develop Source Separation algorithm |
| 5. | Perceive challenges in development of source separation algorithm keeping different issues in real life data.  |

### Course Outcomes:

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | distinguish Single channel Signal Processing and Multi-channel Signal Processing. |
|-----|---|

|     |   |
|-----|---|
| CO2 | use the concept of stochastic processes to develop advanced signal processing concept.  |
| CO3 | develop Source separation algorithm using instantaneous mixing model as well as convoluted mixing model.  |
| CO4 | integrate the concept of matrix algebra, probability models, random processes and linear algebra to develop advance Source Separation algorithm |
| CO5 | development of source separation algorithm keeping different issues in real life data.  |

## Syllabus

Lab is the application of the theory (i.e., hands-on experiments related to the course contents). Therefore, EC421 Bio-Medical Electronics & Signal Processing is the syllabus for the BioMedical Signal Processing Lab. Following experiments are the guidelines for the students. However, the questions for exams are not limited to this experiment list.

### List of experiments:

1. Record Multi-Channel Data (EEG, ECG, Speech) in MATLAB using g.tec Amplifier and National Instruments Microphone array system.
2. Implement the concept of Principal component Analysis to get the principal components from mixture signal and evaluate its significance.
3. To measure the non-gaussianity using higher order moments Kurtosis and Negentropy.
4. To separate the individual speaker voice/ artefacts from recorded Multi-channel Biomedical /speech signal using independent component Analysis using instantaneous mixing model.
5. To separate the individual speaker voice from recorded Multi-channel signal using independent component Analysis using convolutive mixture model.

6. To estimate the direction of arrivals (DOA) from recorded two channels Speech Signal.
9. To separate independent component using fixed point ICA.
10. To represent the signal using sparse concept.
11. To decompose and analyse the signal using Empirical Mode decomposition.
12. To classify the biomedical signals/speech signal using spatial filters.

**Text Books:**

1. W. J. Tompkins, “Biomedical Digital Signal Processing”, Prentice Hall, 1993.
2. Eugene N Bruce, “Biomedical Signal Processing and Signal Modeling”, John Wiley & Son’s publication, 2001.

**Reference Book:**

1. Myer Kutz, “Biomedical Engineering and Design Handbook, Volume I”, McGraw Hill, 2009.
2. D C Reddy, “Biomedical Signal Processing”, McGraw Hill, 2005.
3. Katarzyn J. Blinowska, Jaroslaw Zygiereicz, “Practical Biomedical Signal Analysis Using MATLAB”, 1st Edition, CRC Press, 2011.

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

NA

**POs met through Gaps in the Syllabus**

NA

**Topics beyond syllabus/Advanced topics/Design**

Simulations based on advanced topics after completion of compulsory twelve experiments.

## POs met through Topics beyond syllabus/Advanced topics/Design

Assignments & Seminars

### Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure Direct

#### Assessment

| Assessment Tool              | % Contribution during CO Assessment |
|------------------------------|-------------------------------------|
| Progressive Evaluation       | (60)                                |
| Attendance Marks             | 12                                  |
| Lab file Marks               | 12                                  |
| Viva Marks                   | 24                                  |
| Day-to-day performance Marks | 12                                  |
| End SEM Evaluation           | (40)                                |
| Lab quiz Marks               | 20                                  |
| Lab performance Marks        | 20                                  |

#### Indirect Assessment

1. Students' Feedback on Course Outcome.

#### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 3  | 2  | 3  |                                  |    |    |

|            |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |
|------------|---|---|---|---|---|---|---|---|---|---|---|---|--|--|--|
| <b>CO2</b> | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 3 |  |  |  |
| <b>CO3</b> | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |  |  |  |
| <b>CO4</b> | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |  |  |  |
| <b>CO5</b> | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |  |  |  |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) **Mapping between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>          | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors | CO1                   | CD1, CD2, CD5, CD8                 |
| CD2            | Tutorials/Assignments                   | CO2                   | CD1, CD2, CD5, CD8                 |
| CD3            | Seminars                                | CO3                   | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD4            | Mini Projects/Projects                  | CO4                   | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD5            | Laboratory Experiments/Teaching Aids    | CO5                   | CD4, CD5, CD7, CD9                 |
| CD6            | Industrial/Guest Lectures               |                       |                                    |
| CD7            | Industrial Visits/In-plant Training     |                       |                                    |

|     |   |  |  |
|-----|---|--|--|
| CD8 | Self- learning such as use of NPTEL Materials and Internets |  |  |
| CD9 | Simulation  |  |  |

**COURSE INFORMATION SHEET**  
**Radar Engineering**

**Course Code: EC423**

**Course Title: Radar Engineering**

**Pre-requisite(s):** Knowledge of Electromagnetic fields and waves.

**Co- requisite(s):**

**Credits:** L: 3 T: 0 P: 0 C:3

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: Seventh/Four**

**Branch: Electronics & Communication Engineering Name of Teacher:**

**Course Objectives**

This course envisions to impart to students to:

|     |  |
|-----|--|
| 41. | An understanding on Radar Engineering and its applications                         |
| 42. | An understanding of MTI and pulse Doppler Radar                                    |
| 43. | An ability to analyze different RADAR clutters                                     |
| 44. | An understanding of object Tracking by RADAR                                       |
| 45. | An understanding on working of RADAR Receiver and various Antennas used for RADAR. |

**Course Outcomes**

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Demonstrate an understanding on RADAR and its functional principles                 |
| CO2 | Demonstrate an understanding on MTI and pulse Doppler Radar                         |
| CO3 | Analyze and evaluate performance in the presence of different RADAR clutters        |
| CO4 | Demonstrate an understanding of object tracking by RADAR                            |
| CO5 | Demonstrate an understanding on RADAR Receiver and various Antennas used for RADAR. |

## SYLLABUS

| <b>MODULE</b>  | <b>(NO. OF LECTURE HOURS)</b> |
|--|-------------------------------|
| <b>Module – I</b><br><b>INTRODUCTION TO RADAR</b><br>Introduction, Basic Radar, Simple form of Radar equation, Radar Block diagram, Radar frequencies, Applications of Radar, Origin of Radar. Radar Range Equation, Detection of signals in noise, Receiver noise and signal to noise ratio, Integration of Radar pulses, Radar Cross Section of Targets, Pulse repetition frequency. | <b>10</b>                     |
| <b>Module – II</b><br><b>MTI AND PULSE DOPPLER RADAR</b><br>Introduction to Doppler and MTI Radar, Delay line Cancellers, Digital MTI processing, Moving target Detector, Pulse Doppler Radar, Non Coherent MTI.   | <b>7</b>                      |
| <b>Module – III</b><br><b>TRACKING RADAR</b><br>Tracking with Radar, Mono-pulse tracking, Conical Scan and sequential lobbing, tracking in Range.  | <b>7</b>                      |
| <b>Module – IV</b><br><b>RADAR CLUTTER</b><br>Introduction to Radar Clutter, Surface Clutter radar equation, Land Clutter, Sea Clutter.  | <b>10</b>                     |
| <b>Module – V</b><br><b>RADAR RECEIVER</b><br>Functions of Radar Antennas, Antenna parameters, Antenna radiation pattern and Aperture illumination, Reflector antennas, Electronically steered phase array Antennas. The Radar receiver, Receiver Noise Figure, Super heterodyne receiver, Duplexers and Receiver protectors, Radar Displays   | <b>6</b>                      |

### Text Books:

1. Introduction to Radar Systems”, M I Skolnik, 3/e, Tata McGraw Hill, New Delhi, 2001



**Gaps in the Syllabus (to meet Industry/Profession requirements)**

**POs met through Gaps in the Syllabus:**

**Topics beyond syllabus/Advanced topics/Design :**

**POs met through Topics beyond syllabus/Advanced topics/Design:**

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:PO1**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 1 | 1 | 2 | 1 | - | - | - | - | -  | -  | 2  | 3                                | 2  | 1  |
| CO2            | 3                      | 3 | 3 | 2 | 1 | - | - | - | - | -  | -  | 1  | 3                                | 2  | 2  |
| CO3            | 3                      | 3 | 2 | 2 | 2 | - | - | - | - | -  | -  | 1  | 3                                | 2  | 1  |
| CO4            | 3                      | 2 | 1 | 1 | 1 | - | - | - | - | -  | -  | 1  | 3                                | 2  | 3  |
| CO5            | 3                      | 1 | 1 | 2 | 1 | - | - | - | - | -  | -  | 2  | 3                                | 2  | 2  |

**Correlation Levels 1, 2 or 3 as defined below:**

- 1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD8                           |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1 ,CD8                           |
| CD3            | Seminars  | CO3                   | CD1, CD8                           |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1, CD8                           |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1,CD8                            |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

## COURSE INFORMATION SHEET

**Course code:** EC 425

**Course title:** Optoelectronic Devices

**Pre-requisite(s):** Knowledge of Semiconductor Devices, Digital Electronics

**Co-requisite(s):** None

**Credits:** L: 3 T: 0 P: 0

**Class schedule per week:** 03

**Class:** B. Tech

**Semester / Level:** VII/ 4

**Branch:** ECE Name  
**of Teacher:**

### Course Objectives

This course enables the students:

|    |   |
|----|---|
| 1. | To understand the optical processes in semiconductors.  |
| 2. | To understand the design aspects of semiconductor optical sources and photodetectors for different applications.                              |
| 3. | To understand the methods of modulating a beam of light.  |
| 4. | To understand optoelectronic switching devices and optoelectronic integrated circuits in high speed communication and computing applications. |

### Course Outcomes

After the completion of this course, students will be able to:

|      |  |
|------|--|
| CO1. | Explain the optical properties and processes in semiconductors.                          |
| CO2. | Explain operational characteristics of semiconductor optical sources and photodetectors. |
| CO3. | Explain operational characteristics of photodetectors.                                   |
| CO4. | Apply the optoelectronic modulators in communication and integrated circuits.            |
| CO5. | Develop high speed communication and optical computing system.                           |

## Syllabus

| Module   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <p><b>Module –1:</b><br/>Optical processes in semiconductors, Electron-hole pair formation and recombination, Absorption in semiconductors, Exciton absorption, Impurity band absorption and transitions, Absorption in Quantum wells, Radiation in semiconductors, Exciton recombination, Auger recombination, Time-Resolved Photoluminescence.</p>   | <b>8</b>               |
| <p><b>Module - 2:</b><br/>Semiconductor Heterojunction, Application of Heterojunctions to bipolar transistors, Heterojunction LEDs, Surface emitting LED and edge emitting LEDs, Heterojunction LASERs, Operating principles, Threshold current, Materials, Distributed Feedback LASERs, cleaved-coupled-cavity (C<sup>3</sup>) LASER, Quantum well LASERs, Surface emitting LASERs, Quantum Dot LASERs, Quantum wires LASERs, LASER rate equations. Qswitching, Mode locking.</p> | <b>10</b>              |
| <p><b>Module – 3:</b><br/>Photon detectors, Photoconductors, Heterojunction PIN and APD photodiodes, Superlattice APD, Phototransistor, Metal Semiconductor photodiode, MSM photodiode, Microcavity photodiodes, Solar cells, I-V characteristics, Spectral response, Heterojunction solar cell, Photomultipliers, Thermal detectors.</p>  | <b>7</b>               |
| <p><b>Module – 4:</b><br/>Modulation of Light, Electro-optic effect, Pockels modulator, Kerr modulator, Magneto-optic modulator, Acousto-optic effect, Raman-Nath modulator, Bragg modulator, Quantum well modulators.</p>   | <b>7</b>               |
| <p><b>Module - 5:</b><br/>Optical switching and logic devices, Self-Electro-Optic Effect Device (SEED), Bipolar Controller-Modulator, Optoelectronic Amplifier, MQW-HBT based Programmable Memory Device, Tunable MQW-HBT Logic gate, Optoelectronic integrated circuits (OEIC), Materials and processing, OEIC Transmitters and Receivers.</p>  | <b>8</b>               |

### Text books:

T1. "Semiconductor Optoelectronic Devices" Pallab bhattacharya, PHI.

T2. "Optoelectronics An Introduction", J. Wilson, J.F.B. Hawks, PHI..

**Ref. Books:**

R1. "Semiconductor Nanostructure for Optoelectronic Applications", Todd Steiner.

**R2. "Optical Electronics", Ajoy Ghatak & K.Thyagarajan..**

**R3. "Physics of Semiconductor Devices", S.M.Sze.**

**Gaps in the syllabus (to meet Industry/Profession requirements)**

**POs met through Gaps in the Syllabus**

**Topics beyond syllabus/Advanced topics/Design:**

**POs met through Topics beyond syllabus/Advanced topics/Design**

**Course Delivery Methods**

|     |   |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors      |
| CD2 | Assignments   |
| CD3 | Laboratory experiments/teaching aids/Seminars               |
| CD4 | Industrial/guest lectures                                   |
| CD5 | Industrial visits/in-plant training                         |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation  |

**Course Outcome (CO) Attainment Assessment tools & Evaluation procedure**

**Direct Assessment**

| Assessment Tool | % Contribution during CO Assessment |
|-----------------|-------------------------------------|
| First Quiz      | 10                                  |

|                          |    |
|--------------------------|----|
| Mid Semester Examination | 25 |
| Second Quiz              | 10 |
| Teacher's Assessment     | 5  |
| End Semester Examination | 50 |

**Indirect Assessment –**

1. Student Feedback on Course Outcome

**Mapping between Objectives and Outcomes**

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcomes | Program Outcomes |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|-----------------|------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                 | 1                | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| <b>CO1</b>      | 3                | 3 | 2 | 2 | 2 | 1 | 2 |   | 1 | 2  | 1  | 1  | 3                                | 2  | 2  |
| <b>CO2</b>      | 3                | 3 | 2 | 2 | 3 | 1 | 2 |   | 1 | 2  | 3  | 2  | 3                                | 2  | 2  |
| <b>CO3</b>      | 3                | 3 | 2 | 3 | 3 | 1 | 2 |   | 1 | 2  | 3  | 2  | 3                                | 2  | 2  |
| <b>CO4</b>      | 3                | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2  | 2  | 3  | 2                                | 3  | 2  |
| <b>CO5</b>      | 3                | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 2  | 2  | 3  | 3                                | 2  | 3  |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Low    2: Medium    3: High

**Mapping between Course Outcomes and Course Delivery Method**

| Course Outcomes | Course Delivery Method  |
|-----------------|-------------------------|
| CO1             | CD1, CD2, CD3, CD6, CD7 |
| CO2             | CD1, CD2, CD3, CD6, CD7 |

|     |                         |
|-----|-------------------------|
| CO3 | CD1, CD2, CD3, CD6, CD7 |
| CO4 | CD1, CD2, CD3, CD6, CD7 |
| CO5 | CD1, CD2, CD3, CD6, CD7 |

## COURSE INFORMATION SHEET

**Course Code:** EC427

**Course Title:** Neural Networks and Fuzzy System

**Pre-requisite(s):** Probability and Random Processes

**Co-requisite(s):**

**Credits:** L: 3 T: 0 P: 0

**Class schedule per week:** 03 Class:

**B. Tech.**

**Semester / Level:** 07

**Branch:** Electronics and Communication Engineering  
**Name of Teacher:**

### **Course Objectives**

This course envisions to impart students to:

|     |   |
|-----|---|
| 6.  | Understand the Artificial neural network and different learning strategies.                     |
| 7.  | Develop and design various machine learning techniques such as MLP, RBFNN, FLANN, deep Learning |
| 8.  | Understand the concept of fuzzy logic and its scope.  |
| 9.  | Develop and design fuzzy logic techniques for control, clustering and classification tasks.     |
| 10. | Develop and analyze real time applications using machine learning and fuzzy logic techniques.   |

### **Course Outcomes**

After the completion of this course, students will be able to:



|     |   |
|-----|---|
| CO1 | Design and analyze neural network structures and its learning algorithms.   |
| CO2 | Develop and apply the neural network techniques to solve the complex pattern recognition, classification, clustering and prediction problems. |
| CO3 | Apply and analyse the advanced machine learning techniques such as FLANN, Deep Learning, CNN  |
| CO4 | Create and analyze fuzzy logic theory, techniques and systems.  |
| CO5 | Develop fuzzy logic techniques for control, prediction and clustering applications.   |

## SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <b>Module – I</b><br>Fundamental concepts, Introduction to artificial neural networks (ANN), Learning strategies: supervised & unsupervised learning, error correction learning, Hebbian learning, competitive learning, Kohonen self-organizing networks, vector quantization learning, reinforcement learning.  | <b>8</b>               |
| <b>Module – II</b><br>Perceptron architecture: Single and multi neuron perceptron, Perceptron learning rule, ADALINE network, LMS algorithm, Linear separable problem, multilayer perceptron networks, back propagation algorithm, virtues and limitations of back propagation, methods of speeding: momentum, variable learning rate, LevenbergMarquardt Algorithm | <b>8</b>               |

|   |          |
|---|----------|
| <b>Module – III</b>   | <b>8</b> |
| Radial basis function networks, interpolation problems, covers theorem, regularization networks, functional expansion networks: functional link artificial neural network (FLANN), Cascaded FLANN, Convolutional neural network, Deep learning, applications to classification and prediction |          |
| <b>Module – IV</b>  | <b>8</b> |
| Fuzzy set theory & rules: Introduction to fuzzy systems, membership function, fuzzy set theory: fuzzy union, intersection and complement, fuzzy relational operations, Fuzzy rules: Linguistics variables, fuzzy IF-Then rules, Fuzzy reasoning   |          |
| <b>Module – V</b>   | <b>8</b> |
| Fuzzy inference systems: Introduction, Mamdani fuzzy model, Sugeno fuzzy model, Tekamoto fuzzy model, Neuro-fuzzy systems, applications to fuzzy control, clustering and classification.  |          |

**Text Books:**

5. “Neural network Design”- M.T. Hagan, B. Demuth & M. Beale, Thomson Learning, 2002
6. “Neuro-Fuzzy and Soft Computing”- J.S.R. Jang, C. T. Sun and E. Mizutani, PHI, NewDelhi

**Reference Books:**

1. “Neural Networks: A comprehensive Foundation” – Simon Haykin, Pearson education Gaps in the syllabus (to meet Industry/Profession requirements): N/A

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

NA

**POs met through Gaps in the Syllabus**

PO8 will cover through paper writing/ technical report writing/ assignments/mini projects

**Topics beyond syllabus/Advanced topics/Design**

Teaching through Research paper

**POs met through Topics beyond syllabus/Advanced topics/Design****Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure****Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 2                      | 2 | 1 | 3 | 1 |   |   |   | 1 | 1  | 1  | 2  | 1                                | 2  | 2  |
| CO2            | 3                      | 2 | 3 | 3 | 1 | 1 | 1 |   | 1 | 1  | 2  | 2  | 1                                | 2  | 3  |
| CO3            | 2                      | 2 | 1 | 3 | 1 |   |   |   | 1 | 1  | 1  | 2  | 2                                | 3  | 3  |
| CO4            | 3                      | 2 | 3 | 3 | 1 | 1 | 1 |   | 1 | 1  | 2  | 2  | 2                                | 2  | 3  |
| CO5            | 3                      | 2 | 3 | 3 | 2 |   |   |   | 1 | 1  | 1  | 2  | 3                                | 3  | 3  |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD2, CD 8              |
| CD2     | Tutorials/Assignments                                       | CO2            | CD1 and CD9                 |
| CD3     | Seminars  | CO3            | CD1, CD2 and CD3            |
| CD4     | Mini Projects/Projects                                      | CO4            | CD1 and CD2                 |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD1, CD2, CD9               |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9     | Simulation  |                |                             |

## COURSE INFORMATION SHEET

**Course code:** EC429

**Course title:** Device Modeling & Simulation

**Pre-requisite(s):** EC101 Basics of Electronics & Communication Engineering, EC201 Electronic Devices Co- requisite(s):

**Credits:** L: 3 T: 0 P: 0 C: 3

**Class schedule per week:** 03 Class:

B. Tech.

**Semester / Level:** VII/04

**Branch:** ECE

**Name of Teacher:**

### Course Objectives

This course enables the students to:

|    |   |
|----|---|
| 1. | Understand Basic Semiconductor Physics and Modeling.  |
| 2. | Interpret the Basics of MOS Device for Technology Computer Aided Design (TCAD) and apply the perceived knowledge. |
| 3. | Appraise TCAD and Numerical Methods; simulate/evaluate semiconductor device using TCAD and analyze the results.   |
| 4. | Design and Evaluate the characteristics of Deep Sub-Micron Devices through TCAD simulation tool.                  |
| 5. | Create the NMOS/PMOS through device and process simulation of using TCAD.   |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Describe and illustrate the Basic Semiconductor Physics and Modeling. |
|-----|---|

|     |  |
|-----|--|
| CO2 | Sketch characteristics of MOS Device for Technology Computer Aided Design (TCAD) tools and explain them.                                 |
| CO3 | Make use of Numerical Methods and TCAD tool for Device Simulation and and illustrate their characteristics and analyse them.             |
| CO4 | Schematize the Deep Sub-Micron Device, experiment and simulate through TCAD, assess their characteristics and summarize their features.  |
| CO5 | Design the NMOS/PMOS through device and process simulation features of TCAD tool. Schematize their transient responses and analyze them. |

## SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <p><b>Module – I</b></p> <p><b>Basic Semiconductor Physics and Modeling:</b></p> <p>Band Formation Theory of Semiconductor; Concept of Effective Mass. Basic Semiconductor Equations; Carrier transport; Carrier Recombination and Generation; Continuity Equation and Solution, Mobility and Scattering, Different Distribution Laws; Semiconductor Device Modeling: Shockley-Read-Hall (SRH) Generation/Recombination Model, Simple Recombination-Generation Model, Impact Ionization Model, Mobility Model.</p> | <b>8</b>               |

|  |                 |
|--|-----------------|
| <p><b>Module – II</b></p> <p><b>Basics of MOS Device for Technology Computer Aided Design (TCAD):</b><br/> Operation of MOSFET with Zero Gate Voltage, Operation of MOSFET with a Positive Gate Voltage, Effect of a Small <math>V_{DS}</math>, Operation of MOSFET as <math>V_{DS}</math> is Increased. Expression of Threshold Voltage, I–V Characteristics of MOSFET, Depletion MOSFET, Transconductance (<math>g_m</math>), MOS Transistor as a Switch. MOSFET Capacitances, Interconnect Capacitances. Moore’s Law, MOSFET Scaling; ITRS, SCEs.</p> | <p><b>8</b></p> |
| <p><b>Module – III</b></p> <p><b>Introduction to TCAD, Numerical Methods and Device Simulation Through TCAD:</b></p> <p>TCAD: Process CAD, Device CAD. A Brief History of TCAD; Motivation for TCAD; TCAD Flow for IC Process and Device Simulation; TCAD Application. Numerical Solution Methods, Non-Linear Iteration; Convergence Criteria for Non-Linear Iterations, Initial Guess Requirement, Numerical Method</p>   | <p><b>8</b></p> |
| <p>Implementation, Drift Diffusion Calculations; Energy Balance Calculations; Setting the Number of Carriers.</p>  |                 |
| <p><b>Module – IV</b></p> <p><b>Deep Sub-Micron Device Simulation through TCAD:</b><br/> Introduction, How the Device Simulator ATLAS Works, ATLAS Inputs and Outputs, Simulation Setup, Brief Review of Electro-Physical Models Employed in ATLAS, Choice of METHOD in ATLAS, Mobility Models in ATLAS, Benchmarking of MOSFET Simulations, Importance of Mesh Optimization; <i>Synopsys</i> Technology Computer Aided Design (TCAD) Tool Suite. Device Architecture and Simulation Setup, Advanced Device Structures.</p>                              | <p><b>8</b></p> |

|  |                 |
|--|-----------------|
| <p><b>Module – V</b></p> <p><b>Process Simulation of a MOSFET Using TCAD:</b><br/> Material Initialization, Initial Mesh, N-Buried Layer, Oxidation and Growth of the Initial Oxide, Wafer Masking for Buried Layer Implantation, Screen Oxidation, Buried Layer Implantation, Buried Layer Drive-In, P-Type Epitaxial Growth, Pad Oxide and Gate Oxide Formation, Gate-Poly Deposition and Doping, Gate-Poly Mask, Creation of n+ Source and Drain Regions, Creation of p+ Region, BPSG Deposition and Annealing, Contact Mask Formation and metallization.</p> | <p><b>8</b></p> |
|--|-----------------|

**Textbooks:**

3. Chandan Kumar Sarkar, “Technology Computer Aided design – Simulation for VLSI MOSFET,” CRC Press, Taylor & Francis Group, 2013.
4. Chenming C. Hu, “Modern Semiconductor Devices for Integrated Circuits,” 1st ed., Prentice Hall, 2009.
5. Y. Cheng and C. Hu, “MOSFET Modeling & BSIM3 User’s Guide,” Kluwer Academic Publisher, 2002.

**Reference books:**

1. Silvaco Atlas User Manual, available at [www.silvaco.com](http://www.silvaco.com).
2. Sentaurus TCAD Manuals, Synopsys Inc., Mountain View, CA.
3. Taurus Medici Manuals, Synopsys Inc., Mountain View, CA.

**Gaps in the syllabus (to meet Industry/Profession requirements):**

1. Hands-on-practical for CMOS IC (Integrated Circuit) fabrication.

**POs met through Gaps in the Syllabus:**

10

**Topics beyond syllabus/Advanced topics/Design:**

1. Memory circuits.

**POs met through Topics beyond syllabus/Advanced topics/Design:**

10



## Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

### Direct Assessment

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO2            | 3                      | 3 | 2 | 3 | 3 | 2 | 2 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO3            | 3                      | 3 | 1 | 3 | 3 | 2 | 1 |   |   | 3  |    | 3  | 3                                | 1  | 1  |
| CO4            | 3                      | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO5            | 3                      | 3 | 2 | 3 | 3 | 2 | 2 |   |   | 3  |    | 3  | 3                                | 2  | 1  |

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD7, CD 8                     |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1 and CD9                        |
| CD3            | Seminars  | CO3                   | CD1, CD2 and CD3                   |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1 and CD2                        |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1 and CD2                        |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

## COURSE INFORMATION SHEET

**Course Code: EC431**

**Course Title: Multimedia Communication**

**Pre-requisite(s):** Knowledge of digital image processing and basic understanding of digital communication.

**Co- requisite(s):**

**Credits:** L: 3 T: 0 P: 0 C:3

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: Seventh/Fourth**

**Branch: Electronics & Communication Engineering Name  
of Teacher:**

### **Course Objectives**

This course envisions to impart to students to:

|   |  |
|---|--|
| 1 | An understanding of the concept of technologies for multimedia processing, coding, and communications.                                   |
| 2 | An understanding of state-of-the-art multimedia coding standards, including MPEGx, H.26x, and scalable video coding (SVC).               |
| 3 | An understanding, how to efficiently represent multimedia data   |
| 4 | An understanding, how to deliver multimedia data over a variety of networks?   |
| 5 | An ability to design and provide solutions for practical robust, energy efficient, reliable and secure multimedia communication system.. |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Have an ability to setup a multimedia communication system  |
| CO2 | Have an ability to demonstrate several multimedia standards and provide a new design solutions according to the target applications.  |
| CO3 | To design a video codec system for sending multimedia over the Internet and wireless networks, where video adaptation, error resilience, error concealment, and quality of service are also considered. |
| CO4 | Have an ability to provide practical solutions and apply the subject expertise for the welfare of the society.  |
| CO5 | Have an ability to minimize the design challenges.  |

## SYLLABUS

| <b>MODULE</b>  | <b>(NO. OF LECTURE HOURS)</b> |
|--|-------------------------------|
| <b>Module – I</b><br><br><b>Multimedia communications</b><br><br>Introduction to multimedia communication, multimedia sources, applications of multimedia networks, Audio-Visual Integration: Media interaction, Audio-to-Visual mapping, Joint audio-video coding   | <b>10</b>                     |
| <b>Module – II</b><br><br><b>Multimedia Processing in Communications</b><br><br>Challenges of multimedia information processing, Image & video coding, Signal processing for networked multimedia, NNs for multimedia processing, Multimedia processors.   | <b>7</b>                      |
| <b>Module – III</b><br><br><b>Distributed multimedia system and Multimedia conferencing standards</b><br><br>Main features of a distributed multimedia system, Resource management of distributed multimedia system and networking, Multimedia operating systems, Multimedia conferencing standards: H.320, H.323. | <b>7</b>                      |

|  |                  |
|--|------------------|
| <p><b>Module – IV</b></p> <p><b>Multimedia communication standards</b></p> <p>MPEG approach to standardization, MPEG-1, MPEG-2, MPEG-4, H.261 standard, H.264 standard, Scalable video coding, Multimedia multiplex and Synchronization</p>        | <p><b>10</b></p> |
| <p><b>Module – V</b></p> <p><b>Multimedia communications across networks</b></p> <p>Packet audio/video in the network environment, Video transport across generic networks, Multimedia transport across IP network, Multimedia across wireless</p> | <p><b>6</b></p>  |

**Text Books:**

1. 1. Multimedia Communication Systems: Techniques, Standards, and Networks by K.R.Rao, Zoran S. Bojkovic, and D.A. Milovanovic. Pearson Education Asia, 2002.
2. Compressed Video over Networks, edited by Ming-Ting Sun and Amy R. Reibman, Marcel Dekker Inc., Switzerland, 2000.

**Reference Books:**

1. Multimedia over IP and Wireless Networks: Compression, networking, and Systems, by Mihaela van der Schaar. And Philip Chou, Academic Press, 2007.

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

**POs met through Gaps in the Syllabus:**

**Topics beyond syllabus/Advanced topics/Design :**

**POs met through Topics beyond syllabus/Advanced topics/Design:**

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:PO1**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 1 |   |   |   |   |   |   |   |    |    |    | 3                                | 2  | 1  |
| CO2            | 3                      | 3 |   |   |   | 1 |   |   |   |    |    |    | 3                                | 2  | 2  |
| CO3            | 3                      | 3 |   |   |   | 1 |   |   |   |    |    |    | 3                                | 2  | 1  |
| CO4            | 3                      | 3 | 1 | 3 |   | 1 | 1 |   |   |    |    | 2  | 3                                | 2  | 3  |
| CO5            | 3                      | 3 |   |   |   | 1 |   |   |   |    |    |    | 3                                | 2  | 2  |

**Correlation Levels 1, 2 or 3 as defined below:**

- 1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD8                           |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1 ,CD8                           |
| CD3            | Seminars  | CO3                   | CD1, CD8                           |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1, CD8                           |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1,CD8                            |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |



## COURSE INFORMATION SHEET

**Course code:** EC433

**Course title:** Low Power VLSI Circuits

**Pre-requisite(s):** EC101 Basics of Electronics & Communication Engineering, EC201

**Electronic Devices Co- requisite(s):**

**Credits:** L: 3 T: 0 P: 0 C: 3

**Class schedule per week:** 03 **Class:** B.

**Tech.**

**Semester / Level:** VII/04

**Branch:** ECE

**Name of Teacher:**

### Course Objectives

This course enables the students to:

|    |   |
|----|---|
| A. | Understand nanometre transistor models, power and energy basics.  |
| B. | Interpret the power optimization techniques during design time at circuit, architecture and system level and apply the perceived knowledge. |
| C. | Appraise and analyse the power optimization techniques @ design time for memory, interconnect and clock.                                    |
| D. | Appraise and evaluate power optimization techniques @ Standby for memory, circuits and systems.   |
| E. | Create/design low-power/low-voltage analog circuits in weak inversion.  |

### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Describe and illustrate the nanometre transistor models, power and energy basics.  |
| CO2 | Make use of power optimization techniques @ design time at circuit, architecture and system level; sketch and explain with examples. |

|     |  |
|-----|--|
| CO3 | Experiment with power optimization techniques @ design time for memory, interconnect and clock. Illustrate the benefits of those techniques with design examples and analyse them. |
| CO4 | Apply power optimization techniques @ standby for memory, circuits and systems; Schematize design examples, assess power optimization techniques and summarize their benefits.     |
| CO5 | Design and schematize low-power/low-voltage analog circuits in weak inversion region.  |

### Syllabus

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b></p> <p><b>Nanometer Transistor Models, Power and Energy Basics:</b></p> <p>Nanometer transistor behavior and models, velocity saturation model, alpha power model, leakage currents in a nanometer MOSFET, variability, sources of variability, device and technology innovations; Digital design metrics – power, delay and energy metrics, power-delay and energy– delay trade-offs, dynamic power, short-circuit power, static power, sources of static power dissipation, optimizing power at design time.</p> | <p><b>8</b></p>        |

|  |                 |
|--|-----------------|
| <p><b>Module – II</b></p> <p><b>Optimizing Power @ Design Time: Circuit Level Techniques, Architecture, Algorithms, and Systems:</b></p> <p>Optimization framework for energy–delay trade-off, dynamic-power optimization, multiple supply voltages, transistor sizing, technology mapping, static-power optimization, multiple thresholds, Transistor stacking; The</p> | <p><b>8</b></p> |
|--|-----------------|

|   |  |
|---|--|
| <p>architecture/system trade-off space, concurrency improves energy-efficiency, exploring alternative topologies, removing inefficiency, and the cost of flexibility.</p> |  |
|---|--|

|   |                 |
|---|-----------------|
| <p><b>Module – III</b></p> <p><b>Optimizing Power @ Design Time: Memory, Interconnect and Clocks:</b></p> <p>Role of memory in ICs, Cache Memory Architectures, SRAM Metrics, Power breakdowns of SRAM, Power-saving techniques for SRAM, Non-traditional cells, 6T SRAM Cell with Feedback; Interconnect basics, ITRS projection on interconnect and clock, Increasing Impact of Interconnect, Novel interconnect media, Lower Bounds on Interconnect Energy, Reducing Interconnect Power/Energy, Wire Energy–Delay Trade-off.</p> | <p><b>8</b></p> |
|---|-----------------|

|  |                 |
|--|-----------------|
| <p><b>Module – IV</b></p> <p><b>Optimizing Power @ Standby: Memory, Circuits and Systems:</b></p> <p>Standard SRAM cells and SRAM metrics, optimizing power @ standby, data retention voltage (DRV) and transistor sizes, RBB and VSS raising. Sleep Mode Management, Trade-Off between Sleep Modes and Sleep Time, Dynamic power in standby – Clock gating to reduce power, Sleep Transistor sizing and Placement, Power gating, Dynamic Body Biasing, Supply voltage ramping, Boosted-Gate MOS (BGMOS), Boosted-Sleep MOS, Virtual Supplies.</p> | <p><b>8</b></p> |
| <p><b>Module – V</b></p> <p><b>Design of Low-Power/Low-Voltage Analog Circuits in Weak Inversion</b></p> <p>Minimum Saturation Voltage, Cascode mirror in weak or moderate inversion, low-voltage amplifiers: CMOS inverter-amplifier, Maximum Transconductance-to-Current Ratio: Differential Pair, Linearized differential pair; Single-Stage</p>  | <p><b>8</b></p> |
| <p>Operational Transconductance Amplifiers (OTA): Voltage follower for a resistive load; Exponential Characteristics: Voltage and Current Reference, Minimum Energy Point Analysis.</p>  |                 |

**Textbooks:**

6. Jan M. Rabaey, “Low power essentials”, First Edition, Springer, 2009, ISBN 978-0-38771712-8.
7. Alice Wang, Benton H. Calhoun, A. P. Chandrakasan “Sub-threshold Design for Ultra Low-Power Systems”, Springer, 2006, ISBN-13: 978-0387335155.

**Reference Book:**

1. Kaushik Roy, Sharat Prasad, “Low power CMOS VLSI circuit design”, John Wiley sons Inc., 2000.

2. Jan M. Rabaey, “Digital Integrated Circuits - A Design Perspective”, 2nd Edition, Prentice Hall, 2003.
3. P. Rashinkar, Paterson and L. Singh, “Low Power Design Methodologies”, Kluwer Academic, 2002.

**Gaps in the syllabus (to meet Industry/Profession requirements):**

1. Hands-on-practical for CMOS IC (Integrated Circuit) fabrication.

**POs met through Gaps in the Syllabus:**

10

**Topics beyond syllabus/Advanced topics/Design:**

1. RF circuits.

**POs met through Topics beyond syllabus/Advanced topics/Design:**

10

**Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure**

**Direct Assessment**

| <b>Assessment Tool</b>   | <b>% Contribution during CO Assessment</b> |
|--------------------------|--|
| First Quiz               | 10   |
| Mid Semester Examination | 25   |
| Second Quiz              | 10   |
| Teacher’s Assessment     | 5  |
| End Semester Examination | 50   |

## Indirect Assessment

### 1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 2 | 3 | 3 | 1 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO2            | 3                      | 3 | 1 | 3 | 3 | 3 | 2 |   |   | 3  |    | 3  | 3                                | 1  | 1  |
| CO3            | 3                      | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO4            | 3                      | 3 | 1 | 3 | 3 | 2 | 2 |   |   | 3  |    | 3  | 3                                | 1  | 1  |
| CO5            | 3                      | 3 | 2 | 3 | 3 | 2 | 2 |   |   | 3  |    | 3  | 3                                | 2  | 1  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD7, CD 8              |
| CD2     | Tutorials/Assignments                   | CO2            | CD1 and CD9                 |
| CD3     | Seminars                                | CO3            | CD1, CD2 and CD3            |
| CD4     | Mini Projects/Projects                  | CO4            | CD1 and CD2                 |
| CD5     | Laboratory Experiments/Teaching Aids    | CO5            | CD1 and CD2                 |

|     |   |  |  |
|-----|---|--|--|
| CD6 | Industrial/Guest Lectures                                   |  |  |
| CD7 | Industrial Visits/In-plant Training                         |  |  |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |  |  |
| CD9 | Simulation  |  |  |

**COURSE INFORMATION SHEET**

**Course Code: EC 435**

**Course Title: ASIC Design**

**Pre-requisite(s): VLSI Systems, Digital System Design Co-requisite(s):**

**Credits: L: 3 T: 0 P: 0**

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level:**

**Branch: Electronics & Communication Engineering Name  
of Teacher:**

### Course Objectives

This course envisions imparting to students to:

|    |   |
|----|---|
| 1. | Recognize the fundamental of Semicustom IC Design   |
| 2. | Show the importance of VHDL in Semicustom IC Design |
| 3. | Analyze the Sequential processing in System Design  |
| 4. | Design the highly secure optimized systems          |
| 5. | Develop a processor using VHDL.                     |

### Course Outcomes

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Recognize the importance of Semicustom ICs Design.            |
| CO2 | Design the optimize architecture using VHDL.                  |
| CO3 | Develop the sequential processing unit for customized system. |
| CO4 | Develop the highly secure system for various applications.    |
| CO5 | Design a processor using VHDL.                                |

### SYLLABUS

| <b>MODULE</b>   | <b>(NO. OF LECTURE HOURS)</b> |
|---|-------------------------------|
| <b>Module – I</b><br><b>Introduction to VHDL:</b> System design with uses, History of VHDL, Simulation fundamentals, Modeling hardware, and Language basics, Building blocks in VHDL, Design units and library. | <b>8</b>                      |



|  |          |
|--|----------|
| <p>Module – II</p> <p><b>Sequential Processing:</b> Process statement, Signal vs variable assignment, Sequential statements, For loop, While loop, Condition statements, Examples of half adder and full adder, Test bench.</p>  | <b>8</b> |
| <p>Module – III</p> <p><b>Data Types and Subprograms:</b> Data types, Scalar, Composite, Access type, File type; Arrays; Objects, Signal variables, Constants and files, Association lists, Interface lists, Structural description, Examples, Subprogram, Functions, Conversion function, Resolution functions, Procedures.</p> | <b>8</b> |
| <p>Module – IV</p> <p><b>Packages and VHDL Synthesis:</b> Packages, Package declaration, deferred constants, Subprogram declaration. Simple gate - concurrent assignment, IF control flow statement, Case control flow statement, Simple sequential</p>  | <b>8</b> |
| <p>statements, Asynchronous reset, Asynchronous preset and clear, Complex sequential statements.</p>   |          |
| <p>Module – V</p> <p><b>Combinational &amp; Sequential Circuit Design using VHDL:</b> Multiplexers, Decoders, Encoder, Code Converter, Flip-flops, Counters, Registers, Memory design, processor design.</p>   | <b>8</b> |

**Text Books:**

1. “VHDL” by Douglas Perry, TMH, 1999.
2. **VHDL SYNTHESIS** by J. Bhasker, BS Publication 2004.

## Reference Books:

1. Fundamental of Digital Logic with VHDL DESIGN, by Stephen Brown I Zvonko Vranesic, The McGraw-Hill Companies.

**Gaps in the syllabus (to meet Industry/Profession requirements):** N/A

**POs met through Gaps in the Syllabus:** PO8 will be met through report writing/presentation based assignment

**Topics beyond syllabus/Advanced topics/Design:** Teaching through paper

**POs met through Topics beyond syllabus/Advanced topics/Design:** Teaching through latest research paper

## Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

### Direct Assessment

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

## Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2  | 3  | 2  | 2                                | 3  | 2  |
| CO2            | 3                      | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3  | 3  | 2  | 2                                | 3  | 2  |

|            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <b>CO3</b> | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 1 |
| <b>CO4</b> | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 1 |
| <b>CO5</b> | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 1 |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD7, CD8                      |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1 and CD9                        |
| CD3            | Seminars  | CO3                   | CD1, CD2 and CD3                   |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1 and CD2                        |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1 and CD2                        |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

## **COURSE INFORMATION SHEET**

**Course Code: EC 437**

**Course Title: VLSI System Testing**

**Pre-requisite(s):** Electronic Devices, VLSI Systems, IC Technology **Co-requisite(s):**

**Credits:** L: 3 T: 0 P: 0

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: VII**

**Branch: Electronics & Communication Engineering Name of Teacher:**

**Course Objectives**

This course envisions imparting to students to:

|    |   |
|----|---|
| 1. | Recognize the need of Testing of ICs                              |
| 2. | Check the universal test sets for complex circuits                |
| 3. | Analyze the CMOS testing  |
| 4. | Design for testability  |
| 5. | Recognize the advantage of Built-in self-test in complex circuits |

### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Recognize the importance of Testing of ICs                         |
| CO2 | Perform the universal test sets for complex circuits               |
| CO3 | Develop a algorithm for CMOS testing                               |
| CO4 | Design for testability   |
| CO5 | Recognize the advantages of Built-in self-test in complex circuits |

### SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <p><b>Module – I</b></p> <p><b>Basics of Testing:</b> Fault models, Combinational logic and fault simulation, Test generation for Combinational Circuits. Current sensing based testing, Classification of sequential ATPG methods, Fault collapsing and simulation.</p> | 8                      |

|  |                 |
|--|-----------------|
| <p>Module – II</p> <p><b>Universal test sets:</b> Pseudo exhaustive and iterative logic array testing, Clocking schemes for delay fault testing, Testability classifications for path delay faults, Test generation and fault simulation for path and gate delay faults.</p> | <p><b>8</b></p> |
| <p><b>Module – III</b></p> <p><b>CMOS testing:</b> Testing of static and dynamic circuits, Fault diagnosis, Fault models for diagnosis, Cause effect diagnosis, and Effect cause diagnosis.</p>  | <p><b>8</b></p> |
| <p><b>Module – IV</b></p>  | <p><b>8</b></p> |
| <p><b>Design for testability:</b> Scan design, Partial scan, use of scan chains, boundary scan, DFT for other test objectives, Memory Testing.</p>   |                 |
| <p><b>Module – V</b></p> <p><b>Built-in self-test:</b> Pattern Generators, Estimation of test length, Test points to improve testability, Analysis of aliasing in linear compression, BIST methodologies, BIST for delay fault testing.</p>                                  | <p><b>8</b></p> |

**Text Books:**

1. N. Jha & S.D. Gupta, "Testing of Digital Systems", Cambridge, 2003.
2. W. W. Wen, "VLSI Test Principles and Architectures Design for Testability", Morgan Kaufmann Publishers.2006

**Reference Books:**

1. Michael L. Bushnell & Vishwani D. Agrawal," Essentials of Electronic Testing for Digital, memory & Mixed signal VLSI Circuits", Kluwar Academic Publishers.2000.
2. P. K. Lala," Digital circuit Testing and Testability", Academic Press.1997.
3. M. Abramovici, M. A. Breuer, and A.D. Friedman, "Digital System Testing and Testable Design", Computer Science Press, 1990.
4. Recent literature in VLSI System Testing.

**Gaps in the syllabus (to meet Industry/Profession requirements):** N/A

**POs met through Gaps in the Syllabus:** PO8 will be met though report writing/presentationbased assignment

**Topics beyond syllabus/Advanced topics/Design:** Teaching through paper

**POs met through Topics beyond syllabus/Advanced topics/Design:** Teaching through latest research paper

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) | Program Specific Outcomes (PSOs) |
|----------------|------------------------|----------------------------------|
|                |                        |                                  |

|            | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|
| <b>CO1</b> | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2  | 3  | 2  | 2  | 3  | 1  |
| <b>CO2</b> | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3  | 3  | 2  | 2  | 3  | 1  |
| <b>CO3</b> | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2  | 2  | 2  | 2  | 3  | 2  |
| <b>CO4</b> | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3  | 2  | 2  | 2  | 3  | 1  |
| <b>CO5</b> | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2  | 3  | 2  | 3  | 3  | 1  |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|------|---|----------------|-----------------------------|
| CD1  | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD7, CD8               |
| CD2  | Tutorials/Assignments                                       | CO2            | CD1 and CD9                 |
| CD3  | Seminars  | CO3            | CD1, CD2 and CD3            |
| CD4  | Mini Projects/Projects                                      | CO4            | CD1 and CD2                 |
| CD5  | Laboratory Experiments/Teaching Aids                        | CO5            | CD1 and CD2                 |
| CD6  | Industrial/Guest Lectures                                   |                |                             |
| CD7  | Industrial Visits/In-plant Training                         |                |                             |
| CD8  | Self- learning such as use of NPTEL Materials and Internets |                |                             |
| CD9  | Simulation  |                |                             |



## **COURSE INFORMATION SHEET**

**Course code: EC439**

**Course title: Integrated Circuit Technology**

**Pre-requisite(s): EC101 Basics of Electronics & Communication Engineering, EC201 Electronic Devices Co- requisite(s):**

**Credits: L: 3 T: 0 P: 0 C: 3**

**Class schedule per week: 03 Class:**

B. Tech.

**Semester / Level: VII/04**

**Branch: ECE Name  
of Teacher:**

### **Course Objectives**

This course enables the students to:

|    |   |
|----|---|
| 1. | Understand Clean Room and Wafer Cleaning Technology.                                  |
| 2. | Appraise the Crystal Growth Techniques and Epitaxy and apply the obtained knowledge.  |
| 3. | Appraise and analyse the Film Formation Methods.                                      |
| 4. | Perceive Impurity Incorporation Techniques and evaluate them.                         |
| 5. | Apprehend Lithography and Etching Methods and create layers on devices applying them. |

### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Describe importance of Clean Room and Wafer Cleaning Technology. Illustrate with example.                              |
| CO2 | Sketch and explain the Crystal Growth Techniques and Epitaxy.  |
| CO3 | Illustrate with the sketch the Film Formation Methods. Diagram their characteristics and analyse them.                 |
| CO4 | Appraise the Impurity Incorporation Techniques, schematize their characteristics, assess and summarize their features. |
| CO5 | Schematize the Lithography and Etching Methods. Schematize their characteristics and prepare an inference.             |

### SYLLABUS

| MODULE | (NO. OF LECTURE HOURS) |
|--------|------------------------|
|        |                        |

|  |                 |
|--|-----------------|
| <p><b>Module – I</b></p> <p><b>Clean Room and Wafer Cleaning Technology:</b></p> <p>Environment for VLSI Technology: Clean room classification, Clean room design concept, clean Room Performance Criteria, Clean room installation, Clean room operations, automation, related facility systems, safety requirements. Basic concepts of Wafer cleaning.</p>   | <p><b>8</b></p> |
| <p><b>Module – II</b></p> <p><b>Crystal Growth Techniques and Epitaxy:</b></p> <p>Process Flow, Silicon Crystal Growth from the Melt: Starting Material, The Czochralski Technique, Distribution of Dopant, Effective Segregation Coefficient; Silicon Float-Zone Process; GaAs Crystal-Growth Techniques: Starting Materials, Crystal-Growth Techniques; Material Characterization: Crystal Defects; Epitaxial-Growth Techniques: Chemical-Vapor Deposition, CVD for Silicon, CVD for GaAs, Metalorganic CVD, Molecular-Beam Epitaxy.</p> | <p><b>8</b></p> |
| <p><b>Module – III</b></p> <p><b>Film Formation Methods:</b></p> <p>Thermal Oxidation; Dielectric Deposition: Silicon Dioxide, Silicon Nitride, LowDielectric-Constant Materials, High-Dielectric-Constant Materials; Polysilicon Deposition; Metallization: Physical-Vapor Deposition, Chemical-Vapor Deposition, CVD-W, CVD TiN; Aluminum Metallization: Junction Spiking, Electromigration; Copper Metallization: Damascene technology; ChemicalMechanical Polishing, Silicide.</p>   | <p><b>8</b></p> |
| <p><b>Module – IV</b></p> <p><b>Impurity incorporation Techniques:</b></p> <p>Basic Diffusion Process; Extrinsic Diffusion: Concentration-Dependent Diffusivity, Diffusion in Silicon, Zinc Diffusion in Gallium Arsenide, Diffusionrelated processes: Lateral Diffusion, Impurity Redistribution during Oxidation; Ion Implantation: Range of implanted ions, Ion Distribution, Ion Stopping, Ion Channeling; Implant damage and annealing; Implantation-Related Processes.</p>   | <p><b>8</b></p> |

|  |                 |
|--|-----------------|
| <p><b>Module – V</b></p> <p><b>Lithography and Etching Methods:</b></p> <p>Optical Lithography: Masks, Photoresist, Pattern Transfer, Resolution Enhancement Techniques; Next-Generation Lithographic Methods: Electron-Beam Lithography, The Proximity Effect, Extreme-Ultraviolet Lithography, XRay Lithography, Ion-Beam Lithography; Wet Chemical Etching, Dry Etching, Plasma Fundamentals, Reactive Plasma-Etching Applications.</p> | <p><b>8</b></p> |
|--|-----------------|

**Textbooks:**

1. S. M. Zee, Semiconductor Devices: Physics and Technology, 2e, Wiley, 2002
2. C. Y. Chang and S. M. Sze (Ed), ULSI Technology, McGraw Hill Companies Inc, 1996.
3. James D. Plummer, Michael D. Deal, Peter B. Griffin, Silicon VLSI Technology - Fundamentals, Practice and Modeling, Prentice Hall, 2000.

**Reference books:**

1. S. K. Ghandhi, VLSI Fabrication Principles, John Wiley Inc., New York, 1983.
2. S. M. Sze, VLSI Technology, 2e, McGraw-Hill, 1988.

**Gaps in the syllabus (to meet Industry/Profession requirements):**

1. Hands-on-practical for CMOS IC (Integrated Circuit) fabrication.

**POs met through Gaps in the Syllabus:**

10

**Topics beyond syllabus/Advanced topics/Design:**

1. Fabrication Techniques of CNFET
2. Fabrication Techniques of TFET
3. Fabrication Techniques of MTJ
4. Fabrication Techniques of Memristor
5. Fabrication Techniques of SET 6. Fabrication Techniques of RTD.

**POs met through Topics beyond syllabus/Advanced topics/Design:**

10

**Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 1 | 3 | 3 | 1 | 1 |   |   | 3  |    | 3  | 3                                | 1  | 1  |
| CO2            | 3                      | 3 | 1 | 3 | 3 | 3 | 2 |   |   | 3  |    | 3  | 3                                | 1  | 1  |
| CO3            | 3                      | 3 | 2 | 3 | 3 | 3 | 1 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO4            | 3                      | 3 | 2 | 3 | 3 | 2 | 2 |   |   | 3  |    | 3  | 3                                | 2  | 1  |
| CO5            | 3                      | 3 | 2 | 3 | 3 | 2 | 2 |   |   | 3  |    | 3  | 3                                | 2  | 1  |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD7, CD 8                     |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1 and CD9                        |
| CD3            | Seminars  | CO3                   | CD1, CD2 and CD3                   |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1 and CD2                        |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1 and CD2                        |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

## COURSE INFORMATION SHEET

**Course code:** EC441

**Course title:** Introduction to MEMS (open elective)

**Pre-requisite(s):** Fundamental concept of Mechanical Engg, Electrical Engg, Instrumentation, Physics & Material Science

**Co- requisite(s):** Basics of transducer and sensor

**Credits:** L:3 T :0 P :0 C:3

**Class schedule per week:** 03/week

**Class:** B. Tech

**Semester / Level:** Seventh

**Branch:** ECE Name

**of Teacher:**

**Course Objectives**

This course enables the students:

|    |  |
|----|--|
| 1. | To understand the Fundamental concepts of MEMS technology  |
| 2. | To classify different micro sensors and micro actuators  |
| 3. | To acquire basic knowledge about application of MEMS in different areas and physical modeling used in MEMS Design. |
| 4. | To understand different Microfabrication techniques, MEMS materials and design issues                              |
| 5. | To understand the integration and packaging of MEMS devices.   |

### Course Outcomes

After the completion of this course, students will be able to :

|      |  |
|------|--|
| CO1. | Demonstrate knowledge on fundamental principles and concepts of MEMS Technology  |
| CO2. | Analyze various techniques for building micro-devices in silicon, polymer, metal and other MEMS materials  |
| CO3. | Apply different fabrication methodology used in MEMS devices.  |
| CO4. | Analyze micro-systems technology for technical feasibility as well as practicality using modern tools and relevant simulation software to perform design and analysis. |

|      |   |
|------|---|
| CO5. | Design and analyze Different MEMS Devices using physical, chemical, mechanical and electrical properties of MEMS material. and principles involved in the design and operation of micro-devices |
|------|---|

## SYLLABUS

| MODULE   | (NO. OF LECTURE HOURS) |
|--|------------------------|
| <p><b>Module – I</b></p> <p><b>Introduction :</b> The History of MEMS Development ,Intrinsic characteristics of MEMS .</p> <p><b>Introduction to microfabrication.:</b> Essential overview of frequently used micro fabrication processes. Thin film deposition techniques ,wafer bonding Silicon Based MEMS processes ,MEMS Materials</p>                                 | <b>10</b>              |
| <p><b>Module – II</b></p> <p><b>Essential Electrical and Mechanical Concepts:</b> General Scalar relation between Tensile stress and strain, Mechanical properties of silicon and related thin films, Flexural Beam bending Analysis ,Dynamic System ,Resonant Frequency and quality factor ,Electromechanical and Direct Analogy in Electrical and Mechanical domain.</p> | <b>9</b>               |
| <p><b>Module – III</b></p> <p><b>Sensing and Actuation schemes:</b> Electrostatic Sensors and Actuators, Thermal sensors and actuators, Piezoresistive Sensors, Piezoelectric Sensors and Actuators, Magnetic Actuators</p>  | <b>8</b>               |
| <p><b>Module – IV</b></p>  | <b>7</b>               |



|   |          |
|---|----------|
| Introduction of MEMS switches .MEMS Inductor and MEMS capacitor – classification and design issues.MEMS Packaging and Integration. . Role of MEMS packages. |          |
| <b>Module – V</b><br><br><b>Case studies for selected MEMS Products:</b> Blood Pressure Sensor, Microphone, Accelerometer, Performance and Accuracy         | <b>6</b> |

**Text Books:**

1. Foundations of MEMS by Chang Liu, Second Edition ,Pearson, ISBN 978-81-317-6475-6
2. RF MEMS and Their Applications, Vijay K.Varadan, K.J.Vinoy and K.A.Jose, Wiley India Pvt Ltd.,Wiley India Edition, ISBN 978-81-265-2991-9

**Reference Book:**

1. MarcMadou, Fundamentals of Microfabrication by, CRC Press, 1997.Gregory Kovacs, Micromachined Transducers Sourcebook WCB McGraw-Hill, Boston, **1998**.
2. M.-H. Bao, Micromechanical Transducers: Pressure sensors, accelerometers, and gyroscopes by Elsevier, New York, 2000.

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

4. By attending workshop and hands on training in Industry or Institute -IISC Bangalore, IITs Through INUP **The Indian Nanoelectronics Users Program**

**POs met through Gaps in the Syllabus**

**3,5,9**

**Topics beyond syllabus/Advanced topics/Design :**

Simulation and Modelling and analysis , MEMS device characterization-  
**POs met through Topics beyond syllabus/Advanced topics/Design**  
**2,3,4,12**

**Course Outcome (CO) Attainment Assessment tools & Evaluation procedure**

**Direct Assessment**

| <b>Assessment Tool</b>    | <b>% Contribution during CO Assessment</b> |
|---------------------------|--|
| Mid SEM Examination Marks | 25   |
| End SEM Examination Marks | 50   |
| Quizzes                   | 10+10                                      |
| Assessment by teacher     | 5  |

**Indirect Assessment**

2. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| <b>Course Outcome</b> | <b>Program Outcomes (POs)</b> |          |          |          |          |          |          |          |          |           |           |           | <b>Program Specific Outcomes (PSOs)</b> |           |           |
|-----------------------|-------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|---|-----------|-----------|
|                       | <b>1</b>                      | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>6</b> | <b>7</b> | <b>8</b> | <b>9</b> | <b>10</b> | <b>11</b> | <b>12</b> | <b>13</b>                               | <b>14</b> | <b>15</b> |
| <b>CO1</b>            | 3                             | 3        | 3        | 1        |          |          |          |          | 2        | 2         |           |           | 3                                       | 1         | 1         |
| <b>CO2</b>            | 3                             | 3        | 3        | 3        | 2        |          | 2        |          | 2        | 3         | 1         |           | 3                                       | 1         | 1         |
| <b>CO3</b>            |                               | 3        | 3        | 1        | 3        |          | 3        |          | 2        | 3         |           |           | 3                                       | 2         | 1         |
| <b>CO4</b>            | 3                             | 3        | 3        | 1        |          |          | 1        |          |          |           |           | 2         | 3                                       | 2         | 1         |

|     |   |   |  |  |   |  |  |  |   |  |   |  |   |   |   |
|-----|---|---|--|--|---|--|--|--|---|--|---|--|---|---|---|
| CO5 | 3 | 1 |  |  | 1 |  |  |  | 1 |  | 1 |  | 3 | 2 | 1 |
|-----|---|---|--|--|---|--|--|--|---|--|---|--|---|---|---|

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| CD Code | Course Delivery Methods                                     | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors                     | CO1            | CD1, CD2, CD7,CD 8          |
| CD2     | Tutorials/Assignments                                       | CO2            | CD2,CD5, CD4                |
| CD3     | Seminars  | CO3            | CD2, CD6,CD 8,CD9           |
| CD4     | Mini Projects/Projects                                      | CO4            | CD4,CD5,CD6 ,CD7            |
| CD5     | Laboratory Experiments/Teaching Aids                        | CO5            | CD1,CD6 ,CD8,               |
| CD6     | Industrial/Guest Lectures                                   |                |                             |
| CD7     | Industrial Visits/In-plant Training                         |                |                             |
| CD8     | Self- learning such as use of NPTEL Materials and Internets |                |                             |

## COURSE INFORMATION SHEET

Course code: EC443

Course title: **Introduction to Human- Machine Interface**

Pre-requisite(s): None

Co- requisite(s):

Credits:            L: 3    T: 0    P: 0

Class schedule per week: 03

Class: B. Tech.

Semester / Level: 04

Branch: ECE

Name of Teacher:

### Course Objectives

This course enables the students:

|    |   |
|----|---|
| 1. | To understand the concept of human commuter interaction.        |
| 2. | To interpret different kinds of brain signal.                   |
| 3. | To understand the human-machine interaction using Brain signal. |
| 4. | To Learn about Brain Computer interface                         |
| 5. | To develop the BCI system.                                      |

### Course Outcomes

After the completion of this course, students will be able to:

|      |   |
|------|---|
| CO1. | Explain the concept of human commuter interaction.              |
| CO2. | Identify and Interpret different kinds of brain signal.         |
| CO3. | Develop human-machine interaction using Brain signal.           |
| CO4. | Integrate BCI system using different kind of Biomedical Signals |
| CO5  | To develop the real time BCI inference and decision system.     |

## SYLLABUS

| <b>MODULE</b>  | <b>(NO. OF LECTURE HOURS)</b> |
|--|-------------------------------|
| <p><b>Module – I</b></p> <p>Brain Structures and Scalp Potentials, Neural Activities, Measuring Electric Activity in the brain EEG, MEG and SSVEP, Wearable and Wireless EEG Monitoring, Brain Rhythms. Event-Related Potentials, Detection, Separation, Localization, and Classification of P300 Signals.</p> | <b>8</b>                      |
| <p><b>Module – II</b></p> <p>10-20 Electrode Placement System, EEG Recording and Measurement, Wireless multi-channel EEG Recording System, Artifact identification from EEG and MEG, ERD and ERS, Lapalacian Referencing, Common Average Referencing.</p>  | <b>9</b>                      |

|  |                 |
|--|-----------------|
| <p><b>Module – III</b></p> <p>Cognitive State Estimation Problem, Spatial filters, Common Spatial Pattern, CSP based Cognitive State Estimation. EEG source localization, General Approaches to Source Localization, ICA Method, MUSIC Algorithm, RAP MUSIC, FOCUSS Algorithm, Determination of the Number of Sources.</p> | <p><b>9</b></p> |
| <p><b>Module – IV</b></p> <p>Instantaneous BSS, BSS based EEG Signal Analysis, Validity of the basic ICA model, Artifact removal from EEG and MEG, Topography Mapping of Independent Components.</p>   | <p><b>8</b></p> |
| <p><b>Module – V</b></p> <p>Wearable and Wireless EEG based Brain-Computer Interface, Wireless Electroencephalogram, Information System using WLAN, BCI performance Evaluation parameters, Feature Extraction, Thought Recognition, Linear classification.</p>   | <p><b>6</b></p> |

**Text Books:**

1. Saied Sanei and J.A. Chambers, EEG Signal Processing, John Wiley & Sons Ltd., 2007.

2. Guido Dornhege, Jos´e del R. Mill´an Thilo Hinterberger, Dennis J. McFarland, KlausRobert Muller, Toward Brain-Computer Interfacing ,MIT Press Cambridge, 2007.
3. Rangaraj M. Rangayyan, Biomedical Signal Analysis- A case-study approach, IEEE Press, 2005.
4. D.C. Reddy, Biomedical Signal Processing – principles and techniques, Tata McGrawHill, New Delhi, 2009.

### **Gaps in the Syllabus (to meet Industry/Profession requirements)**

**Introduction to Human- Machine Interface** is an open course; hence it only lays down the foundation of pattern recognition and classification problem.

### **POs met through Gaps in the Syllabus**

May be met through laboratory simulations, experiments, and design problems.

### **Topics beyond syllabus/Advanced topics/Design**

9. Application of **Introduction to Human- Machine Interface** in the development of BCI system.
10. Extraction of Pattern vector from time varying signal for the development of decision support system for various applications.

### **POs met through Topics beyond syllabus/Advanced topics/Design**

Assignments & Seminars

### **Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure**

### **Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

### Indirect Assessment

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  |                                  |    |    |
| CO2            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  |                                  |    |    |
| CO3            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 3 | 3 | 3  | 3  | 3  |                                  |    |    |
| CO4            | 2                      | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 3 | 3  | 3  | 3  |                                  |    |    |
| CO5            | 1                      | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1  |    | 1  |                                  |    |    |



**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Mapping between COs and Course Delivery (CD) methods**

| <b>CD Code</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|----------------|---|-----------------------|------------------------------------|
| CD1            | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD2, CD5, CD8                 |
| CD2            | Tutorials/Assignments                                       | CO2                   | CD1, CD2, CD5, CD8                 |
| CD3            | Seminars  | CO3                   | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD4            | Mini Projects/Projects                                      | CO4                   | CD1, CD2, CD3, CD4, CD5, CD8, CD9. |
| CD5            | Laboratory Experiments/Teaching Aids                        | CO5                   | CD4, CD5, CD7, CD9                 |
| CD6            | Industrial/Guest Lectures                                   |                       |                                    |
| CD7            | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8            | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9            | Simulation  |                       |                                    |

## COURSE INFORMATION SHEET

**Course Code: EC 445**

**Course Title: Introduction to Signal Processing**

**Pre-requisite(s): NIL Co- requisite(s):**

**Credits: L: 3 T: 1 P: 0**

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: 7**

**Branch: Electronics and Communication Engineering Name  
of Teacher:**

### **Course Objectives**

This course envisions to impart students to:

|     |  |
|-----|--|
| 46. | Understand the fundamentals of signal and system.                                      |
| 47. | Interpret the different transform techniques of signal processing.                     |
| 48. | Understand time domain and frequency domain signal analysis                            |
| 49. | Demonstrate the analog and digital filtering process.                                  |
| 50. | Explain the concept of random variables and parameter estimation in signal processing. |

### **Course Outcomes**

After the completion of this course, students will be able to:

|     |   |
|-----|---|
| CO1 | Explain the fundamentals of signal and system   |
| CO2 | Interpret the different transform techniques of signal processing.                          |
| CO3 | Implement the time domain and frequency domain signal analysis for particular applications. |
| CO4 | Design and apply the analog and digital filters.  |
| CO5 | Apply digital filtering and signal estimation to retrieve information from noisy data.      |

**SYLLABUS**

| <b>MODULE</b>   | <b>(NO. OF LECTURE HOURS)</b> |
|---|-------------------------------|
| <b>Module – I</b><br>Introduction and Basics: Signals and Systems; Classification of Signals, System Properties; Linear Algebra Basics-Vectors, Orthogonality, Eigenvalues and Eigenvectors.  | <b>6</b>                      |
| <b>Module – II</b><br>Continuous Signals and Systems: Laplace Transform, Fourier Transform, Transfer Functions, Causality and Stability, Poles/Zeros; Differential Equations, Steady State and Transient Responses, and Convolution Integral.   | <b>8</b>                      |
| <b>Module – III</b><br>Discrete-Time Signals and Systems: LTI Systems; Z-transform; Digital filters; Difference Equations; Causality and stability; Convolution and Correlation; Discrete Fourier Transform (DFT), FFT and Window Function; Frequency Analysis of Signals and Systems; Data Acquisition: Sampling theorem; Sampling of Bandpass Signals; Quantization; A/D conversion; D/A conversion; Sampling and Reconstruction; Interpolation and Decimation. | <b>10</b>                     |
| <b>Module – IV</b><br>Digital Filter Design: Butterworth, Elliptic, Chebyshev low-pass filters. Filter Realizations; Conversion to high-pass, band-pass, band-stop filters. Discrete-time filters: IIR and FIR. Linear phase filters. Frequency sampling filters.   | <b>8</b>                      |
|   |                               |

|  |          |
|--|----------|
| <b>Module – V</b><br>Probability and Random Signals: Random variables; probability density functions (PDFs); Moments and Cumulants; Multivariate distributions; Time averages, Ensemble averages, Autocorrelation functions, Crosscorrelation function; Estimation of parameters of random signals; Linear prediction; Auto-regressive model; Nonlinear models of signals; Analysis of Nonstationary signals | <b>8</b> |
|--|----------|

**Text Books:**

2. Oppenheim, A. S. Willsky and H. Nawab, "Signals and Systems," 2nd Ed., Prentice-Hall, 1996.
3. Papoulis and S. U. Pillai, "Probability, Random Variables, and Stochastic Processes," McGraw Hill, 2001.

**Reference Books:**

1. 1. A. V. Oppenheim, Ronald W. Schafer and John R. Buck, "Discrete-Time Signal Processing," 2nd Ed., Prentice Hall, 1999.
2. J. G. Proakis, and D. K. Manolakis, "Digital Signal Processing," 4th Ed., Prentice Hall, 2006.

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

NA

**POs met through Gaps in the Syllabus****Topics beyond syllabus/Advanced topics/Design**

Teaching through research paper

**POs met through Topics beyond syllabus/Advanced topics/Design****Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure****Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**

1. Students' Feedback on Course Outcome.

### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 2                      | 2 |   | 2 | 1 |   |   |   | 1 | 1  | 1  | 2  |                                  |    |    |
| CO2            | 3                      | 3 |   | 2 | 2 |   |   |   | 1 | 2  | 1  | 2  |                                  |    |    |
| CO3            | 2                      | 3 | 1 | 1 | 3 |   |   |   | 1 | 1  | 1  | 2  |                                  |    |    |
| CO4            | 3                      | 3 |   | 2 | 3 |   |   |   | 1 | 1  | 1  | 2  |                                  |    |    |
| CO5            | 3                      | 2 | 1 | 1 | 2 |   |   |   | 1 | 1  | 1  | 2  |                                  |    |    |

### Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

### Mapping Between COs and Course Delivery (CD) methods

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD7, CD 8              |
| CD2     | Tutorials/Assignments                   | CO2            | CD1 and CD9                 |
| CD3     | Seminars                                | CO3            | CD1, CD2 and CD3            |
| CD4     | Mini Projects/Projects                  | CO4            | CD1 and CD2                 |
| CD5     | Laboratory Experiments/Teaching Aids    | CO5            | CD1 and CD2                 |
| CD6     | Industrial/Guest Lectures               |                |                             |

|     |   |  |  |
|-----|---|--|--|
| CD7 | Industrial Visits/In-plant Training                         |  |  |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |  |  |
| CD9 | Simulation  |  |  |

## COURSE INFORMATION SHEET

**Course Code: EC 447**

**Course Title: Electronic Packaging**

**Pre-requisite(s):** Material physics, Electronics components/devices, Fundamental of IC Technology **Co- requisite(s):**

**Credits:** L: 3 T: 0 P: 0

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: VII**

**Branch: Electronics & Communication Engineering Name  
of Teacher:**

### Course Objectives

This course envisions imparting to students to:

|    |   |
|----|---|
| 1. | Realize the need of Electronic Packaging.                                     |
| 2. | Recognize the Chip Scale Packaging.   |
| 3. | Understand the procedure to develop compact system using electronic packaging |
| 4. | Recognize the role of materials in electronic packaging                       |
| 5. | Analyze the different types of packaging techniques.                          |

### Course Outcomes

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Recognize the importance of electronic packaging         |
| CO2 | Analyze the Chip Scale Packaging in robust system.       |
| CO3 | Develop a compact system using electronic packaging.     |
| CO4 | Study the role of materials in electronic packaging      |
| CO5 | Demonstrate the different types of packaging techniques. |

### SYLLABUS



| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b></p> <p><b>Introduction to Electronic Packaging:</b> Fundamental of Electronic packaging, issue in electronic packaging, hierarchy of interconnection levels, blue gene, breakthrough in chip packaging technology, SMD benefits and drawback.</p>  | 8                      |
| <p>Module – II</p> <p><b>Chip Scale Packaging:</b> Step packaging, silicon wafer, low density SMD process from silicon wafer to package, wafer preparation and dicing, die attach and wire bonding, molding&amp; solder plating, marking and lead trim, chip attachment to the package substrate, chip package connection: tape automated bonding, flip-chip.</p> | 8                      |
| <p><b>Module – III</b></p> <p><b>Materials used in electronic packaging:</b> Metals, metal alloys, lead poisoning, RoHS directive, ceramics, properties of ceramics and glasses, plastics(polymers), glass transition and melting point, characteristics of package, thermal behavior of package, thermal resistance, thermal aspect in package density.</p>      | 8                      |
| <p><b>Module – IV</b></p> <p><b>Electrical model of the package:</b> SPICE Simulation for strong and weak driver, parasitic capacitance as function of the interconnect, crosstalk, power</p>   | 8                      |

|   |                 |
|---|-----------------|
| <p>integrity and distribution, ground bounce, power/ground count, evolution in power/ground layout, manufacturability, testability, evolution technology, reliability.</p>  |                 |
| <p><b>Module – V</b></p> <p><b>IC package types:</b> Dual inline package(DIP), pin grid array(PGA), ceramic lead less chip(CLLC), small outline package(SOP), plastic lead less chip connection(PLCC), quad flat package(QFP), ball grid array(BGA), reduced pin count devices, passive components, advanced packaging: multi-chip modules(MCM), chip stacked packaged by Intel, chip on board mounting(COB).</p> | <p><b>8</b></p> |

**Text Books:**

1. Ammakaia, Fundamentals of Electronic Packaging, John Hopkins Engineering for Professionals
2. T. Di Stefano, Issues Driving Wafer-Level Technologies, Stanford U.
3. Renesas Semiconductor Assembly Service
4. Frear, Materials Issues in Area-Array Microelectronic Packaging
5. Harris & Bushnell, Packages and Power, Rutgers University
6. <http://nptel.ac.in/courses/108108031/module1/Lecture01.pdf>

**Reference Books:**

1. The Nordic Electronics Packaging Guideline
2. Brown, Advanced Electronic Packaging: With Emphasis on MCMs
3. Additional sources for Images/devices: Xilinx, IBM, Bill Bertram (Wikipedia), Farnell, John Fader (Wikipedia), Philips, Maxim, Intel, Fraunhofer Institute, SMART Group, Hochschule Heilbronn, DRS Test & Energy Management, cpu-world.com, hardwarezone.com, Amkor, TI, coolingzone.com, NASA Office of Logic Design, Altera, Fairchild, Emulation Technology, National Semiconductor, OKI, Semiconductor, ASE Malaysia, Pro Systems China, Toshiba

**Gaps in the syllabus (to meet Industry/Profession requirements):** N/A

**POs met through Gaps in the Syllabus:** PO8 will be met through report writing/presentationbased assignment

**Topics beyond syllabus/Advanced topics/Design:** Teaching through paper

**POs met through Topics beyond syllabus/Advanced topics/Design:** Teaching through paper

### Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

#### Direct Assessment

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher's Assessment     | 5                                   |
| End Semester Examination | 50                                  |

#### Indirect Assessment

1. Students' Feedback on Course Outcome.

#### Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2  | 3  | 2  | 1                                | 3  | 2  |
| CO2            | 3                      | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3  | 3  | 2  | 2                                | 3  | 2  |
| CO3            | 3                      | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2  | 2  | 2  | 1                                | 3  | 1  |
| CO4            | 3                      | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3  | 2  | 2  | 1                                | 3  | 1  |
| CO5            | 3                      | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2  | 3  | 2  | 1                                | 3  | 1  |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| <b>CDCode</b> | <b>Course Delivery Methods</b>                              | <b>Course Outcome</b> | <b>Course Delivery Method Used</b> |
|---------------|---|-----------------------|------------------------------------|
| CD1           | Lecture by use of Boards/LCD Projectors                     | CO1                   | CD1, CD7, CD8                      |
| CD2           | Tutorials/Assignments                                       | CO2                   | CD1 and CD9                        |
| CD3           | Seminars  | CO3                   | CD1, CD2 and CD3                   |
| CD4           | Mini Projects/Projects                                      | CO4                   | CD1 and CD2                        |
| CD5           | Laboratory Experiments/Teaching Aids                        | CO5                   | CD1 and CD2                        |
| CD6           | Industrial/Guest Lectures                                   |                       |                                    |
| CD7           | Industrial Visits/In-plant Training                         |                       |                                    |
| CD8           | Self- learning such as use of NPTEL Materials and Internets |                       |                                    |
| CD9           | Simulation  |                       |                                    |

## COURSE INFORMATION SHEET

**Course Code: EC449**

**Course Title: Wireless Sensor Networks**

**Pre-requisite(s):** Knowledge of digital electronics, probability theory, basic understanding of communication system.

**Co- requisite(s):**

**Credits:** L: 3 T: 0 P: 0 C:3

**Class schedule per week: 03 Class:**

**B. Tech.**

**Semester / Level: Seventh/Fourth**

**Branch: Electronics & Communication Engineering Name of Teacher:**

### **Course Objectives**

This course envisions to impart to students to:

|     |   |
|-----|---|
| 51. | An understanding of the concept of wireless sensor network and its major challenges.  |
| 52. | An understanding of WSN architecture and its design principles.   |
| 53. | Fundamental understanding on MAC protocols.   |
| 54. | Fundamental understanding on routing protocols.   |
| 55. | An ability to design and provide solutions for practical low cost, energy efficient, reliable and secure wireless sensor network. |

### **Course Outcomes**

After the completion of this course, students will be able to:

|     |  |
|-----|--|
| CO1 | Have an ability to evaluate wireless sensor network based on its performance and minimize the design challenges. |
|-----|--|

|     |  |
|-----|--|
| CO2 | Have an ability to demonstrate several architectures of WSN and provide a new design solutions according to the required applications. |
| CO3 | Have an ability to design several MAC protocols for WSNs.  |
| CO4 | Have an ability to design several Routing and transport protocols for WSNs.  |
| CO5 | Have an ability to provide practical solutions and apply the subject expertise for the welfare of society.                             |

## SYLLABUS

| MODULE  | (NO. OF LECTURE HOURS) |
|---|------------------------|
| <p><b>Module – I</b></p> <p><b>INTRODUCTION TO WIRELESS SENSOR NETWORKS</b></p> <p>Fundamentals of Wireless Communication Technology, The Electromagnetic Spectrum, Radio propagation Mechanisms, Characteristics of the Wireless Channel, mobile ad hoc networks (MANETs) and wireless sensor networks (WSNs) :concepts and architectures, Applications of Ad Hoc and Sensor networks, Design Challenges in Ad hoc and Sensor Networks.</p>      | <p><b>10</b></p>       |
| <p><b>Module – II</b></p> <p><b>SINGLE NODE AND NETWORK ARCHITECTURE</b></p> <p>single node architecture: hardware and software components of a sensor node , WSN Network Architecture: typical network architectures-data relaying and aggregation strategies, Energy consumption of sensor nodes, Operating system and execution environments, sensor network scenarios, Optimization goals and figures of merit, Design principles of WSNs</p> | <p><b>7</b></p>        |
| <p><b>Module – III</b></p> <p><b>MAC PROTOCOLS FOR WIRELESS SENSOR NETWORKS</b></p> <p>Fundamental of MAC protocols, MAC protocols for WSNs, Low duty cycle protocols and wakeup concepts, contention based and scheduled based protocols (LEACH, SMACS, and TRAMA), IEEE 802.15.4 MAC protocols, Topology control and clustering.</p>  | <p><b>7</b></p>        |
| <p><b>Module – IV</b></p> <p><b>ROUTING AND TRANSPORT CONTROLS PROTOCOL</b></p> <p>Routing challenges and design issues in WSNs, Wireless network routing protocols, Energy efficient unicast routing, energy efficient broadcast /multicast routing, Geographical routing, traditional transport control protocols, Design issues of transport control protocols, CODA, ESRT, RMST, PSFQ, GRAUDA and Ad hoc Transport protocols (ATP)</p>        | <p><b>10</b></p>       |

|   |                 |
|---|-----------------|
| <p><b>Module – V</b></p> <p><b>LOCALIZATION AND POSITIONING:</b></p> <p>Properties of localization and positioning procedures, possible approaches: Proximity, Trilateration and Triangulation, Mathematical basics for the lateration problem, single hop localization, positioning in multihop environment.</p> | <p><b>6</b></p> |
|---|-----------------|

**Text Books:**

1. Kazem Sohraby, Daniel Minoli, Taieb Znati, “Wireless Sensor Networks’, John Wiley & Sons Inc. Publication, 2007
2. Holger Karl, and Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks” John Wiley & Sons Inc. Publication.

**Gaps in the Syllabus (to meet Industry/Profession requirements)**

**POs met through Gaps in the Syllabus:**

**Topics beyond syllabus/Advanced topics/Design :**

**POs met through Topics beyond syllabus/Advanced topics/Design:**

**Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:PO1**

**Direct Assessment**

| Assessment Tool          | % Contribution during CO Assessment |
|--------------------------|-------------------------------------|
| First Quiz               | 10                                  |
| Mid Semester Examination | 25                                  |
| Second Quiz              | 10                                  |
| Teacher’s Assessment     | 5                                   |
| End Semester Examination | 50                                  |

**Indirect Assessment**



1. Students' Feedback on Course Outcome.

**Mapping of Course Outcomes onto Program Outcomes**

| Course Outcome | Program Outcomes (POs) |   |   |   |   |   |   |   |   |    |    |    | Program Specific Outcomes (PSOs) |    |    |
|----------------|------------------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------|----|----|
|                | 1                      | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13                               | 14 | 15 |
| CO1            | 3                      | 1 |   |   |   |   |   |   |   |    |    |    | 3                                | 2  | 1  |
| CO2            | 3                      | 3 |   |   |   | 1 |   |   |   |    |    |    | 3                                | 2  | 2  |
| CO3            | 3                      | 3 |   |   |   | 1 |   |   |   |    |    |    | 3                                | 2  | 1  |
| CO4            | 3                      | 3 |   |   |   | 1 |   |   |   |    |    |    | 3                                | 2  | 3  |
| CO5            | 3                      | 3 | 1 | 3 |   | 1 | 1 |   |   |    |    | 2  | 3                                | 2  | 2  |

**Correlation Levels 1, 2 or 3 as defined below:**

1: Slight (Low)    2: Moderate (Medium)    3: Substantial (High)

**Mapping Between COs and Course Delivery (CD) methods**

| CD Code | Course Delivery Methods                 | Course Outcome | Course Delivery Method Used |
|---------|---|----------------|-----------------------------|
| CD1     | Lecture by use of Boards/LCD Projectors | CO1            | CD1, CD8                    |
| CD2     | Tutorials/Assignments                   | CO2            | CD1 ,CD8                    |
| CD3     | Seminars                                | CO3            | CD1, CD8                    |
| CD4     | Mini Projects/Projects                  | CO4            | CD1, CD8                    |
| CD5     | Laboratory Experiments/Teaching Aids    | CO5            | CD1,CD8                     |
| CD6     | Industrial/Guest Lectures               |                |                             |

|     |   |  |  |
|-----|---|--|--|
| CD7 | Industrial Visits/In-plant Training                         |  |  |
| CD8 | Self- learning such as use of NPTEL Materials and Internets |  |  |
| CD9 | Simulation  |  |  |