BIRLA INSTITUTE OF TECHNOLOGY

NEP-2020 CURRICULUM BOOK

(Effective from Academic Session: Monsoon 2024)

Bachelor of Technology

DEPARTMENT
OF
ELECTRONICS AND COMMUNICATION ENGINEERING

INSTITUTE VISION

To become a Globally Recognized 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

DM1: 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.

DM2: 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.

DM3: To pursue high quality contemporary research through continued interaction with research organizations and industries.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1: 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.

PEO2: To build confident and competent graduates capable of designing and testing electronic devices and communication systems for the given specifications.

PEO3: To inculcate an attitude to work in a team using technical knowhow, software tools and interdisciplinary working environments to achieve project goals.

PEO4: To nurture effective communication and interpersonal skills to demonstrate leadership qualities and exhibit professional ethics.

PEO5: To develop an ability, enthusiasm and understanding for life-long learning development and motivation towards higher studies and research.

PROGRAMME OUTCOMES (POs)

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WKl to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WKl to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WKl, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Annexure:

Knowledge and Attitude Profile (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: Apply the knowledge acquired in basic sciences and engineering for solving electronic and communication engineering problems.

PSO2: Build competence in design and analysis of electronics and communication systems.

PSO3: Develop skills to carry out research in electronic instrumentation, signal processing, VLSI systems, microwave engineering, wireless communication and networking.

Mapping of POs and PSOs with PEOs

	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	3	3	2	2	2
PO2	3	3	2	2	2
PO3	3	3	2	2	2
PO4	3	3	2	2	2
PO5	3	3	2	2	2
PO6	2	2	3	3	3
PO7	3	2	3	3	3
PO8	2	3	3	3	1
PO9	2	3	3	3	2
PO10	1	2	2	1	2
PO11	3	2	1	1	3
PSO1	3	3	2	1	2
PSO2	3	3	2	1	2
PSO3	3	2	1	1	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

Mapping of Department Mission (DM) with PEOs

	DM1	DM2	DM3
PEO1	3	2	3
PEO2	3	3	3
PEO3	3	3	2
PEO4	2	2	2
PEO5	2	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

Birla Institute of Technology, Mesra, Ranchi

Course Structure for B.Tech. (Electronics and Communication Engineering)

Based on NEP-2020, CBCS and OBE, Effective from 2024-2025

Sr. No.	Semester of Study (Recommended)	Category of Course	Course Code	Subjects	Mode of Delivery & Credits *L-Lecture; T-Tutorial; P-Practical*			Total Credits
					L *(Periods/ Week)*	T *(Periods/ Week)*	P *(Periods/ Week)*	
	FIRST	**THEORY**						
I.1		FS	MA24101	Mathematics - I	3	1	0	4
I.2			CH24101	Chemistry	3	1	0	4
I.3		GE	EC24101	Basic Electronics	2	1	0	3
I.4			ME24101	Basics of Mechanical Engineering	2	1	0	3
I.5		FS	CE24101	Environmental Science	2	0	0	2
		LABORATORIES						
I.6		FS	CH24102	Chemistry Lab	0	0	2	1
I.7		GE	EC24102	Basic Electronics Lab	0	0	2	1
I.8			ME24102	Engineering Graphics	0	0	4	2
I.9			PE24102	Workshop Practice	0	0	2	1
I.10		MC	MC24 101/ 102 /103/ 104/105	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA) /Entrepreneurship	0	0	2	1
TOTAL (Theory + Labs)								**22**
	SECOND	**THEORY**						
II.1		FS	MA24103	Mathematics - II	3	1	0	4
II.2			PH24101	Physics	3	1	0	4
II.3			BE24101	Biological Science for Engineers	2	0	0	2
II.4		GE	CS24101	Programming for Problem Solving	3	1	0	4
II.5			EE24101	Basics of Electrical Engineering	2	1	0	3
		LABORATORIES						
II.6		FS	PH24102	Physics Lab	0	0	2	1
II.7		GE	CS24102	Programming for problem Solving Lab.	0	0	2	1
II.8			EE24102	Electrical Engineering Lab.	0	0	2	1
I.9		HSS	HS24131	Communication Skill - I	0	0	3	1.5
I.10		MC	MC24 106 /107/108/ 109/110	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA) /Entrepreneurship	0	0	2	1
TOTAL (Theory + Labs)								**22.5**
GRAND TOTAL FOR FIRST YEAR								**44.5**

Vocational Courses for Exit after 1st Year								
Vocational Course I: EC24190 Analog and Digital Circuit Design					1	0	4	**3**
Vocational Course II: EC24192 Electronic Equipments Servicing and Maintenance					1	0	4	**3**
		THEORY						
III.1	THIRD	PC	EC24201	Electronic Devices	3	1	0	4
III.2			EC24203	Digital System Design	3	0	0	3
III.3			EC24205	Network Theory	3	1	0	4
III.4			EC24207	Signals and Systems	3	0	0	3
III.5			EC24209	Probability and Random Processes	3	0	0	3
III.6		HSS	MT24131	UHV-II: Understanding Harmony	3	0	0	3
		LABORATORIES						
III.7		PC	EC24202	Electronic Devices Lab	0	0	2	1
III.8		PC	EC24204	Digital System Design Lab	0	0	2	1
III.9		MC	MC24 201/202/ 203/204 / 205	Choice of: NCC/NSS/ PT & Games/ Creative Arts (CA) / Entrepreneurship	0	0	2	1
	TOTAL (Theory + Labs)							**23**
		THEORY						
IV.1	FOURTH	PC	EC24251	Analog Circuits	3	1	0	4
IV.2			EC24253	Analog Communication	3	1	0	4
IV.3			EC24255	Computer Architecture	3	0	0	3
IV.4			EC24257	VLSI Design	3	1	0	4
IV.5		PE	XX24XXX / MO24201	Open Elective - I / MOOC - I	3	0	0	3
IV.6			HS24211	Indian Knowledge System	2	0	0	0
		LABORATORIES						
IV.7		PC	EC24252	Analog Circuits Lab	0	0	2	1
IV.8		PC	EC24258	VLSI Design Lab	0	0	2	1
IV.9		MC	MC24 206/ 207/208 / 209/ 210	Choice of: NCC/NSS/ PT & Games/ Creative Arts (CA) / Entrepreneurship	0	0	2	1
TOTAL (Theory + Labs)								**21**
GRAND TOTAL FOR SECOND YEAR								**44**
Vocational Courses for Exit after 2nd Year								
Vocational Course III: EC24290 Electronic Instruments and Measurements					1	0	4	**3**
Vocational Course IV: EC24292 Communication Engineering					1	0	4	**3**
		THEORY						
V.1	FIFTH	PC	EC24301	Electromagnetic Fields and Waves	3	1	0	4
V.2		PC	EC24303	Digital Communication	3	0	0	3
V.3		PC	EC24305	Microprocessors	3	0	0	3

V.4	FIFTH	PC	EC24307	Data Communication and Computer Networking	3	1	0	4
V.5		PE	EC24XXX	Program Elective-I (PE-I)	3	0	0	3
V.6		OE	XX24XXX /MO24301	Open Elective - II / MOOC - II	3	0	0	3
		LABORATORIES						
V.7		PC	EC24304	Communication System Lab	0	0	2	1
V.8		PC	EC24306	Microprocessors Lab	0	0	2	1
V.9		PC	EC24300	Project - I				2
TOTAL (Theory + Labs)								**24**
	SIXTH	**THEORY**						
VI.1		PC	EC24351	Digital Signal Processing	3	1	0	4
VI.2		PC	EC24353	Control Systems	3	1	0	4
VI.3		PC	EC24355	Embedded Systems	3	0	0	3
VI.4		PE	EC24XXX	Program Elective-II (PE-II)	3	0	0	3
VI.5		OE	XX24XXX / MO24303	Open Elective - III / MOOC - III	3	0	0	3
VI.6		HSS	MT24204	Constitution of India	2	0	0	0
		LABORATORIES						
VI.7		PC	EC24352	Digital Signal Processing Lab	0	0	2	1
VI.8		PC	EC24356	Embedded Systems Lab	0	0	2	1
VI.9		PE	EC243XXX	Program Elective-II Lab	0	0	2	1
VI.10		PC	EC24350	Project - II				2
VI.11		HSS	HS24133	Communication Skill - II	0	0	3	1.5
TOTAL (Theory + Labs)								**23.5**
GRAND TOTAL FOR THIRD YEAR								**47.5**
	SEVENTH	**THEORY**						
VII.1		PC	EC24401	Microwave Theory and Techniques	3	1	0	4
VII.2		PE	EC24XXX	Program Elective-III (PE-III)	3	0	0	3
VII.3		PE	EC24XXX	Program Elective-IV (PE-IV)	3	0	0	3
VII.4		PE	EC24XXX	Program Elective-V (PE-V)	3	0	0	3
VII.5		OE	XX24XXX / MO24401	Open Elective - IV / MOOC - IV	3	0	0	3
		LABORATORIES						
VII.6		PC	EC24402	Microwave Lab	0	0	2	1
VII.7		MC	MC24400	Summer Training (Minimum Four Weeks / 160 Hrs)				4

VII.8		PC	EC24400	Project - III				3
TOTAL (Theory + Labs)								**24**
VIII.1	EIGHTH	PC	EC24450/ EC24490	Project-IV / Industry Internship				6
VIII.2			EC24498	Comprehensive Viva				2
	TOTAL (Theory + Labs)							**8**
GRAND TOTAL FOR FOURTH YEAR								**32**
GRAND TOTAL FOR B.TECH.								**168**

List of Programme Elective (PE) Courses

[ECE students to choose one from each group]

SEMESTER	Course Code	Name of the PE courses	L	T	P	C
PE-I						
V	EC24309	Information Theory and Coding	3	0	0	3
	EC24311	ASIC Design	3	0	0	3
	EC24313	Artificial Intelligence and Machine Learning	3	0	0	3
PE-II						
VI	EC24357	Fiber Optic Communication	3	0	0	3
	EC24359	Wireless Communication	3	0	0	3
	EC24361	Electronic Measurements	3	0	0	3
Program Elective-II Lab [Choose as per theory course chosen in PE-II]						
VI	EC24358	Fiber Optic Communication Lab	0	0	2	1
	EC24360	Wireless Communication Lab	0	0	2	1
	EC24362	Measurement and Instrumentation Lab	0	0	2	1
PE-III						
VII	EC24403	Mobile & Cellular Communication	3	0	0	3
	EC24405	Satellite Communication	3	0	0	3
	EC24407	Industrial Instrumentation	3	0	0	3
	EC24409	Optimization Techniques	3	0	0	3
	EC24411	Internet of Things	3	0	0	3
	EC24413	Low Power VLSI Circuits	3	0	0	3
PE-IV						
VII	EC24415	Speech and Audio Processing	3	0	0	3
	EC24417	FPGA System	3	0	0	3
	EC24419	Antennas and Wave Propagation	3	0	0	3
	EC24421	Microelectronic Devices and Circuits	3	0	0	3
	EC24423	Nanoelectronics	3	0	0	3
	EC24425	MEMS and Microsystems	3	0	0	3
PE-V						
VII	EC24427	Radar Engineering	3	0	0	3
	EC24429	Wireless Sensors Network	3	0	0	3
	EC24431	Digital Image Processing	3	0	0	3
	EC24433	Bio-Medical Electronics & Signal Processing	3	0	0	3
	EC24435	Deep Learning	3	0	0	3
	EC24437	Electronic Packaging	3	0	0	3
* Programme Electives to be opted only by the ECE Department' UG students						

List of Open Elective (OE) Courses

[Open Electives to be opted only by other departments' students]

SEMESTER	Code No.	Name of the OE courses	Prerequisites courses with code	L	T	P	C
OE-I							
FOURTH	EC24259	Sensors and Transducers	N/A	3	0	0	3
	EC24261	Digital Computer Electronics	N/A	3	0	0	3
	EC24263	Introduction to VLSI Design	N/A	3	0	0	3
OE-II							
FIFTH	EC24321	Introduction to Communication System	N/A	3	0	0	3
	EC24333	Introduction to Microcontrollers	N/A	3	0	0	3
OE-III							
SIXTH	EC24363	Introduction to MEMS	N/A	3	0	0	3
	EC24379	Measurement & Instrumentation	N/A	3	0	0	3
OE-IV							
SEVENTH	EC24439	Introduction to Signal Processing	N/A	3	0	0	3
	EC24441	Electronics Technology	N/A	3	0	0	3
*OPEN ELECTIVES TO BE OPTED ONLY BY OTHER DEPARTMENT STUDENTS							

NEP-2020 Guidelines for Multiple Exit and Multiple Entry

Multiple Exit

Year of Exit	Certification	Credits Required
First Year	Certificate in Engineering	Must have passed 1st year + *6 credits for vocational courses of level-1
Second Year	Diploma in Engineering (Electronics & Communication Engineering)	Must have passed 1st and 2nd year + *6 credits for vocational courses of level-2
Third Year	B Sc. Engineering (Electronics & Communication Engineering)	Must have passed 1st, 2nd and 3rd year

List of Vocational Courses

[Mandatory for students taking exit after 1st or 2nd year]

Year /Level	Vocational Courses Course Code. Course Name	Prerequisites courses with code	L	T	P	C
Vocational Course I & II (After Completing 1st Year)						
FIRST	**Vocational Course I** EC24190 Analog and Digital Circuit Design	N/A	1	0	4	3
	Vocational Course II EC24192 Electronic Equipments Servicing and Maintenance	N/A	-	-	-	3
Vocational Course II I& IV (After Completing 2nd Year)						
SECOND	**Vocational Course III** EC24290 Electronic Instruments and Measurements					
	Vocational Course IV EC24292 Communication Engineering					

Multiple Entry

Will be based on admission test against vacant seats, considering the past academic records/ ABC/CGPA/JEE(Main)/Closing Rank for the corresponding admission year/NIRF/Institute Reputation as well as without violating Institute own admission policy.

Course structure for In-depth Specialization for 2024 Batch and onwards

[To be provided]

Course structure for Minor in ECE for 2024 Batch and onwards

[To be provided]

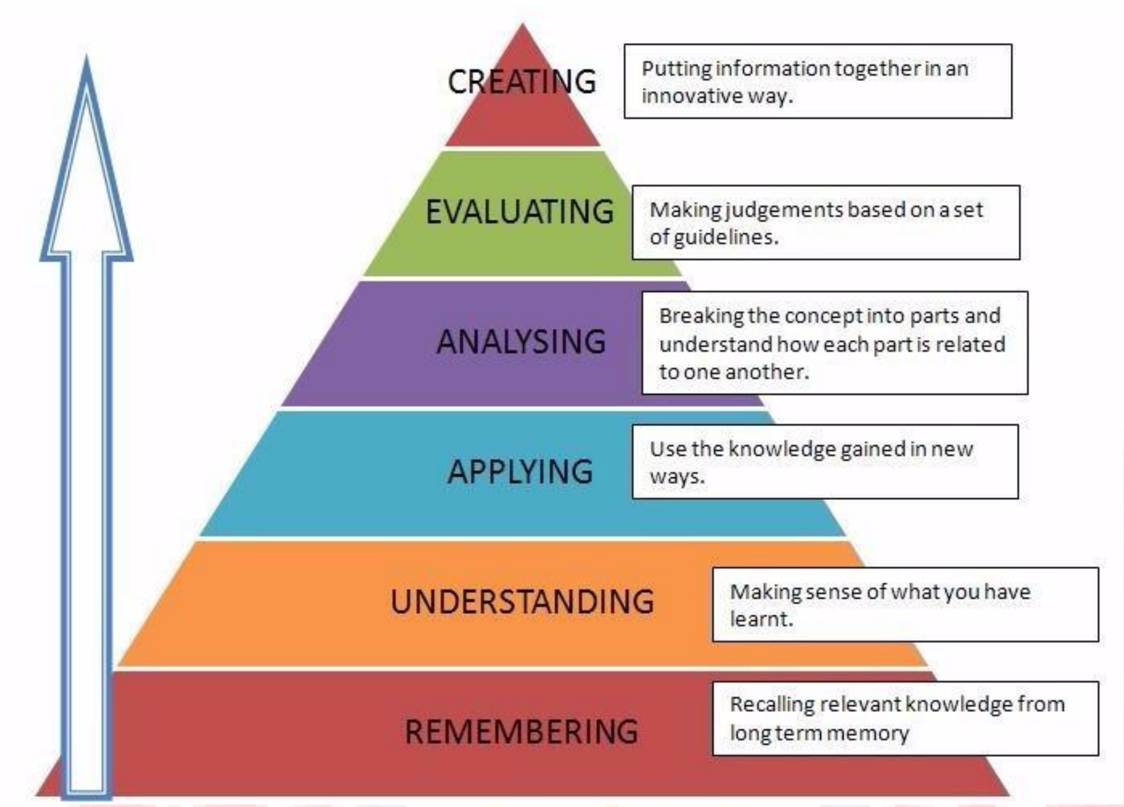
Head
Electronics and Communication Engineering

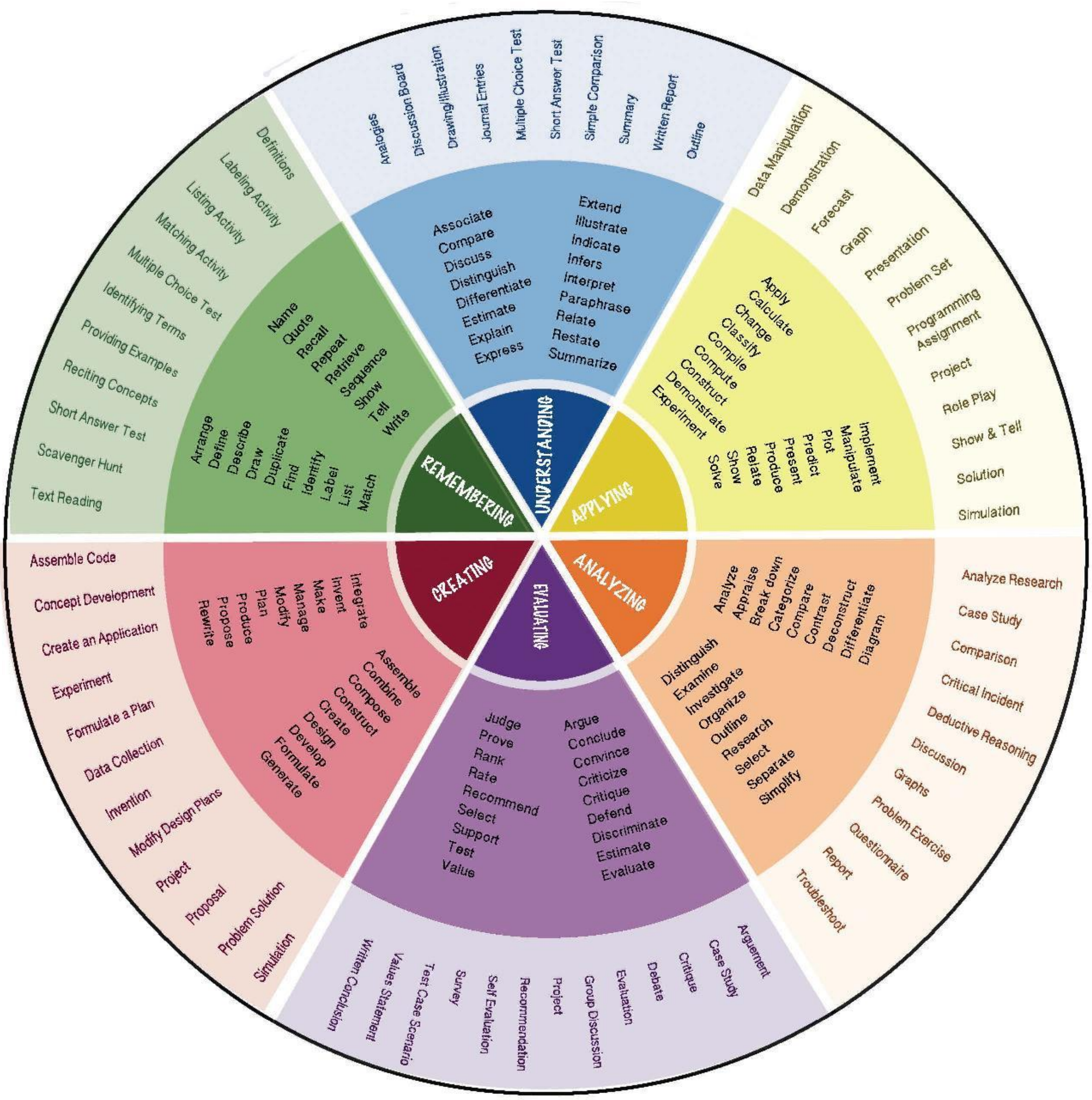
Dean (UGS)

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.


CREATING
Putting information together in an innovative way.
EVALUATING
Making judgements based on a set of guidelines.
ANALYSING
Breaking the concept into parts and understand how each part is related to one another.
APPLYING
Use the knowledge gained in new ways.
UNDERSTANDING
Making sense of what you have learnt.
REMEMBERING
Recalling relevant knowledge from long term memory



Bloom's Taxonomy is used to formulate questions. It facilitates the formulation of action verbs in connection with the various tiers of thinking to achieve a balance between basic retrieval and more complex abilities. Questions at the Remember level, e.g., may use verbs to define or list, questions at the Understand level may use verbs to explain or summarize, at the Apply level use or demonstrate, at the Analyze level differentiate or compare, at the Evaluate level justify or critique, and then at the Create level design or formulate.

Detailed Syllabus
of

A. Common Courses
(1st Year and other)

B. Core Courses

C. Elective Courses
  i. Program Electives
  ii. Open Electives

D. Vocational Courses

COURSE INFORMATION SHEET

Mathematics-I

Course Code: MA24101
Course Title: Mathematics-I
Pre-requisite(s): -
Co- requisite(s): --
Credits: 4 L: 3 T: 1 P: 0
Class schedule per week: 4
Class: B.Tech.
Semester / Level: I/1
Branch: All
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	infinite sequences and series
2.	theory of matrices including elementary transformations, rank and its application in consistency of system of linear equations, eigenvalues, eigenvectors etc.
3.	multivariable functions, partial differentiation, properties and applications of partial derivatives.
4.	integrals of multivariable functions viz. double and triple integrals with their applications
5.	properties like gradient, divergence, curl associated with derivatives of vector point functions and integrals of vector point functions

COURSE OUTCOMES (COs)

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

CO1	decide the behavior of sequences and series using appropriate tests.
CO2	handle problems related to the theory of matrices including elementary transformations, rank and its application in consistency of system of linear equations, eigenvalues, eigenvectors etc.
CO3	get an understanding of partial derivatives and their applications in finding maxima - minima problems.
CO4	apply the principles of integrals (multivariable functions viz. double and triple integrals) to solve a variety of practical problems in engineering and sciences.
CO5	get an understanding of gradient, divergence, curl associated with derivatives of vector point functions and integrals of vector point functions and demonstrate a depth of understanding in advanced mathematical topics, enhance and develop the ability of using the language of mathematics in engineering.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
MODULE – I: Sequences and Series Sequences, Convergence of Sequence. Series, Convergence of Series, Tests for Convergence: Comparison tests, Cauchy's Integral test, Ratio test, Cauchy's root test, Raabe's test, Gauss test, Alternating series, Leibnitz test, Absolute and Conditional Convergence.	**9**
MODULE – II: Matrices Rank of a Matrix, elementary transformations. Vectors, Linear Independence and Dependence of Vectors. Consistency of system of linear equations. Eigenvalues, Eigenvectors, Cayley - Hamilton theorem.	**9**
III: Advance Differential Calculus Function of several variables, Partial derivatives, Euler's theorem for homogeneous functions, Total derivatives, Chain rules, Jacobians and its properties, Taylor series for function of two	**9**

variables, Maxima – Minima.	
MODULE – IV: Advance Integral Calculus Double integrals, double integrals in polar coordinates, Change of order of integration, Triple Integrals, cylindrical and spherical coordinate systems, transformation of coordinates, Applications of double and triple integrals in areas and volumes.	**9**
MODULE – V: Vector Calculus Scalar and vector point functions, gradient, directional derivative, divergence, curl. Line Integral, Work done, Conservative field, Green's theorem in a plane, Surface and volume integrals, Gauss – divergence theorem, Stoke 's theorem.	**9**

TEXTBOOKS:

1. M. D. Weir, J. Hass and F. R. Giordano: Thomas' Calculus, 11th edition, Pearson Educations, 2008E.
2. H. Anton, I. Brivens and S. Davis, Calculus, 10th Edition, John Wiley and sons, Singapore Pte. Ltd., 2013.
3. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint,2010.

REFERENCE BOOKS:

1. M. J. Strauss, G. L. Bradley And K. J. Smith, Calculus, 3rd Ed, Dorling. Kindersley (India) Pvt. Ltd. (P Ed), Delhi, 2007.
2. David C. Lay, Linear Algebra and its Applications (3rd Edition), Pearson Ed. Asia, Indian Reprint, 2007.
3. Robert Wrede & Murray R. Spiegel, Advanced Calculus, 3rd Ed., Schaum's outline series, McGraw-Hill Companies, Inc.,2010.
4. D. G. Zill and W.S. Wright, Advanced Engineering Mathematics, Fourth Edition, 2011.

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
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	

Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

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

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	1	0	0	0	0	1	2			
CO2	3	3	2	2	2	0	0	0	0	1	2			
CO3	3	3	2	2	1	0	0	0	0	1	2			
CO4	3	3	3	3	2	1	0	0	0	1	2			
CO5	3	3	2	3	2	1	1	1	1	2	2			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Chemistry

Course Code: CH24101
Course Title: Chemistry
Pre-requisite(s): Intermediate level Chemistry
Co- requisite(s):
Credits: 4 L: 3 T: 1 P: 0
Class schedule per week: 4
Class: B.Tech.
Semester / Level: I
Branch: All
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students:

1.	To create concept of chemical bonding in coordination chemistry
2.	To understand the basics of stereochemistry, aromaticity and reaction mechanism of organic molecules
3.	To understand the reaction dynamics and to know different types of catalysis
4.	To apprehend the basic principles and the application of vibrational, electronic and NMR spectroscopy
5.	To develop knowledge on the physical state and electrochemistry of molecules

COURSE OUTCOMES (COs) (3 COs to 6 COs depending upon the course)

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

CO1	Able to explain the bonding in a coordination complex
CO2	Able to explain the 3D structure, aromaticity and stereochemistry of organic molecules
CO3	Able to predict the rate, molecularity and mechanism of a simple as well as catalytic reaction
CO4	Able to explain the UV-vis, IR and NMR spectra of unknown molecules
CO5	Able to interpret the phase diagram of simple one and two component heterogeneous systems in equilibrium and the electrochemical behavior of the molecules

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I: Bonding in Coordination Complex Introduction to Chemical Bonding, Werner's Theory, Bonding in coordination complexes, Crystal Field Theory, Octahedral, Tetrahedral and Square planar complexes, CFSE, Jahn Teller theorem, Spectral, electronic and magnetic properties of coordination complexes.	**8**
Module – II: Organic Structure and Reactivity Aromaticity, Geometrical isomerism: cis–trans, E/Z, and syn-anti isomerism; Optical isomerism & Chirality; Wedge, Fischer, Newmann and Sawhorse projection formulae and interconversions; D/L, R/S nomenclature system; Conformational studies of n-butane. Addition, Elimination, Substitution and Rearrangement reaction.	**8**
Module – III: Kinetics and Catalysis Kinetics of Chain, Parallel/Competing/Side, Consecutive reactions; Fast reactions; Outline of Catalysis, Acid-base catalysis, Enzyme catalysis (Michaelis-Menten equation), Important catalysts in industrial processes: Hydrogenation using Wilkinsons catalyst, Phase transfer catalyst**.**	8

Module – IV: Spectroscopic Techniques Absorption Spectroscopy, Lambert-Beers law, Principles and applications of UV-Visible spectroscopy, Principles and applications of Vibrational spectroscopy; Introduction of NMR spectroscopy.	8
Module – V: Phase and Chemical equilibrium Phase rule: terms involved, Phase diagram of one component (Water) &amp; two component (Pb/Ag) system & their applications; Gibbs Free energy, Van't Hoff equation and Chemical Equilibrium; Nernst Equation, Standard electrode potential, EMF measurement and its application, Batteries and Fuel Cells.	8

TEXTBOOKS:

1. Huheey, J. E., Inorganic Chemistry: Principles of Structure and Reactivity, 4 th edition, Pearson.
2. Morrison, R. N. &amp; Boyd, R. N. Organic Chemistry, Seventh Edition, Pearson
3. Atkins, P. W. &amp; Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.

REFERENCE BOOKS:

1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier (2009).
3. William Kemp, Organic Spectroscopy, 3 rd Ed., 2008 Macmillan.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

Limited exposure to computational tools, industrial case studies, and skill-based training needed for industry readiness.

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
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback onCourse Outcome**

COURSE DELIVERY METHODS

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

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	0	0	0	0	1	0	2			
CO2	3	3	2	1	0	0	0	0	1	0	2			
CO3	3	3	3	2	1	1	0	0	1	0	3			
CO4	3	2	1	3	3	0	0	0	2	0	2			
CO5	3	3	2	2	1	2	0	0	1	0	3			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Chemistry Lab

Course Code: CH24102
Course Title: Chemistry Lab
Pre-requisite(s): Intermediate level Chemistry
Co- requisite(s):
Credits: 1 L: 0 T: 0 P: 2
Class schedule per week: 2
Class: B.Tech.
Semester / Level: I
Branch: All
Name of Teacher:

COURSE OBJECTIVES

This course enables the students to:

1.	To gain an understanding of the synthesis of organic and inorganic compounds.
2.	To interpret and analyze spectroscopic data effectively.
3.	To develop a strong concept of potentiometric and pH-metric titrations of acids and bases.
4.	To understand and calculate the rate constant of chemical reactions.
5.	To acquire knowledge of determining melting points and estimating eutectic and transition temperatures.

COURSE OUTCOMES (COs)

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

CO1	Able to perform the synthesis of organic and inorganic compounds.
CO2	Able to interpret and analyze spectroscopic data.
CO3	Able to carry out potentiometric and pH-metric titrations of acids and bases.
CO4	Able to determine the rate constant of chemical reactions.
CO5	Able to measure melting points and estimate eutectic and transition temperatures.

SYLLABUS (List of experiments)

1. Gravimetric estimation of Nickel using Dimethylglyoxime.

2. Determination of total Hardness of a given water Sample (Complexometric Titration).

3. Verification of Beer’s Law using Fe^{3+} solution by spectrophotometer/colorimeter, and determination of the concentration of an unknown Fe^{3+} solution.

4. Preparation of Diazoamino Benzene and reporting of its melting point and yield.

5. Construction of a melting point–mass percent composition diagram for a two-component mixture and determination of its eutectic temperature.

6. Study of the kinetics of acid-catalyzed hydrolysis of ethyl acetate and evaluation of the rate constant.

7. Determination of the strength of a strong acid using potentiometric titration with a strong base.

8. Determination of the transition temperature of a given salt hydrate.

9. Separation of binary organic mixture by acid-base extraction and analysis using given FTIR and NMR spectrum.

10.Construction of a pH-titration curve for a strong acid versus a strong base

REFERENCE MATERIALS:

1. https://bitmesra.ac.in/edudepartment/content/1/140/553 (link of Lab Manual)
2. **Experimental Physical Chemistry** – B. Viswanathan, P. S. Raghavan, Narosa Publishing House (1997).
3. **Vogel's Textbook of Practical Organic Chemistry**
4. **Experiments in General Chemistry** – C. N. R. Rao, U. C. Agarwal.
5. **Experimental Organic Chemistry, Vol. 1 & 2** – P. R. Singh, D. S. Gupta, K. S. Bajpai, Tata 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

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback onCourse Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	Seminars (discussion of experimental results and error analysis).
CD5	Group discussions/problem-solving sessions (to analyze experimental data and calculations).
CD6	Industrial/guest lectures (applications of chemical analysis techniques in industry).
CD7	Industrial visits (exposure to real chemical laboratories and processes).

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	2	2	3	1	1	2	2			
CO2	3	2	2	3	3	2	1	1	3	2	3			
CO3	3	3	1	3	3	1	2	1	2	2	2			
CO4	3	3	1	3	2	1	1	1	1	2	3			
CO5	3	2	1	2	2	2	1	1	1	1	3			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Basics of Mechanical Engineering

Course Code: **ME24101**
Course Title: **Basics of Mechanical Engineering**
Pre-requisite(s): **NIL**
Co- requisite(s): **NIL**
Credits: **3** (L: 2 T:1 P: 0)
Class schedule per week: **3**
Class: **B. Tech**
Semester / Level: **SECOND**
Branch: **Mechanical Engineering**
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Introduce system of forces, and write equation of equilibrium.
2.	Analyse motion of particle and rigid body subjected to force.
3.	Grasp the importance of internal and external combustion engines.
4.	Apprehend the fundamentals of friction.
5.	Understand the different sources of energy.

COURSE OUTCOMES (COs)

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

CO1	Explain the basics of Mechanical Engineering.
CO2	Apply various laws of mechanics on static and dynamic elements and bodies.
CO3	Analyse various problems of mechanics related to static and dynamic bodies.
CO4	Evaluate the real life problem related to mechanics and energy for its probable solution.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I **System of Forces and Structure Mechanics;** Addition of Forces, Moment of a Force, Couple, Varignon's theorem, Free Body Diagram, Equilibrium in Two and Three Dimensions, Equivalent Forces and Moment. Types of Plane Trusses, Analysis of Plane Trusses by: Method of Joints and Method of Sections. Hooke's Law of elasticity, Stress and Strain, Relation between elastic constants.	**8**
Module – II **Kinematics & Kinetics of rigid bodies:** Types of rigid body motion– translation, rotation about fixed axis, equations defining the rotation of a rigid body about a fixed axis, plane motion, absolute and relative velocity in plane motion, instantaneous center of rotation. Equation of motion and D'Alembert's principle.	**8**
Module – III **Friction :** Interfacial Friction (a) Laws of dry friction, static & kinetic co-efficient of friction, Analysis of static, kinetic and rolling friction. (b) Analysis of frictional forces in inclined planes, wedges, screw jacks and belt drives.	**8**
Module – IV **Boilers and Internal Combustion Engine;** Classification of Boilers, Fire tube and Water Tube boilers. Boiler Mountings and Accessories. Boiler efficiency. Classification of I C Engines. Basic components and terminology of IC engines, working principle of four stroke and two stroke - petrol and diesel engine.	**6**

Module – V **Non-Conventional Energy Sources** Renewable and Non-renewable Energy Resources, Advantages and Disadvantages of Renewable Resources, Renewable Energy Forms and Conversion- Solar Energy, Wind Energy, Hydro Energy.	**5**

TEXTBOOKS:

1. Engineering Mechanics, Irving H. Shames, P H I. ltd, 2011.
2. Boiler operator, Wayne Smith, LSA Publishers, 2013.
3. Internal Combustion Engines, M. L. Sharma and R. P. Mathur, Dhanpat Rai Publications, 2014. Fundamentals of Renewable Energy Processes, Aldo Vieira Da Rosa, Elsevier publication, 2012.

REFERENCE BOOKS:

1. Engineering Mechanics : statics, James L. Meriam, L. G. Kraige, Wiley, 7th Edition, 2011.
2. Engineering Mechanics, S. Rajasekaran & G. Sankarasubramaniam, Vikash publishing house, 2018.
3. An Introduction to Steam Boilers, David Allan Low, Copper Press Publisher, 2012.
4. Internal Combustion Engines – V Ganesan, McGraw hill, 2017.
5. Non Conventional Energy Resources, B. H. Khan, McGraw Hill Education Publisher, 2017.
6. Principles of Mechanical Engineering, R. P. Sharma & Chilkesh Ranjan, Global Academic Publishers, 2016.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) : NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Mid Semester Examination	25
Quiz	10
Assignment	10
Teacher’s Assessment	5

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	√	√	√	√
Semester End Examination	√	√	√	√

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

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

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	1		2	1	1		2	2	1	2
CO2	3	3	2	2	2	1	1	2	1	1	2	2	1	2
CO3	3	3	3	3	2	1	1	2	2	2	2	2	2	2
CO4	2	3	3	3	3	2	2	2	2	2	3	2	2	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 6
CO4	CD1, CD2, CD 6

COURSE INFORMATION SHEET

Engineering Graphics

Course Code: **ME24102**
Course Title: **Engineering Graphics**
Pre-requisite(s): **NIL**
Co- requisite(s): **NIL**
Credits:2 (L:0 T: 0 P:4)
Class schedule per week: **4**
Class: **B. Tech.**
Semester / Level: **SECOND**
Branch: **Mechanical Engineering**
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Understand the basic principles of Engineering Graphics, which include projections of 1D, 2D and 3D objects.
2.	Visualize a solid object (including sectioned) and convert it into drawing.
3.	Visualize different views of any object.
4.	Develop skill to draw objects using AutoCAD software.
5.	Inculcate the imagination and mental visualization capabilities for interpreting the geometrical details of common engineering objects.

COURSE OUTCOMES (COs)

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

CO1	Explain the fundamentals of Engineering Graphics and projection and acquire visualization skills.
CO2	Demonstrate the concept of projections of points and lines for various engineering applications.
CO3	Apply the concept of projections to construct planes and solids, and its orthographic projections which are positioned in various configurations..
CO4	Demonstrate the understanding of AutoCAD software commands to draw projections of points, lines, planes and solids.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I Introduction to Engineering Graphics, dimensioning and projections, orthographic projections, Fundamentals of First and Third Angle projection, Orthographic projections of points.	**9**
Module – II Orthographic projections of straight lines: lines parallel to HP and VP, lines inclined to HP and Parallel to VP, line inclined to VP and parallel to HP, line inclined to both reference planes. Orthographic projections of planes/lamina: lamina perpendicular to both HP and VP, lamina parallel to HP and perpendicular to VP (and vice versa), lamina inclined to HP and perpendicular to VP, lamina inclined to VP and perpendicular to HP, lamina inclined to both reference planes.	**9**
Module – III Projections of solids (cube, prism, pyramid, tetrahedron) - axis perpendicular to HP and inclined to VP and inclined to one or both planes. Section of solids: sectional plane perpendicular to one plane and parallel/inclined to another plane.	**9**

Module – IV Working with AutoCAD Commands, Cartesian Workspace, Basic Drawing & Editing Commands, Drawing: Lines, Rectangles, Circles, Arcs, Polylines, Polygons, Ellipses, Creating Fillets and Chamfers, Creating Arrays of Objects, Working with Annotations, Adding Text to a Drawing, Hatching, Adding Dimensions, Dimensioning Concepts, Adding Linear Dimensions, Adding Radial & Angular Dimensions, Editing the Dimensions.	**9**
Module – V Create views of points, lines, planes, and various types of solids (cube, prism, pyramid, tetrahedron, etc.) using AutoCAD software.	**9**

TEXTBOOKS:

1. Engineering Drawing by N. D. Bhatt, Charotar Publishing House Pvt.Ltd., 53rd, Edition, 2014.
2. Engineering Drawing and Graphics + AutoCAD by K. Venugopal, New Age International (P) Limited, 4th Reprint: June, 2017.

REFERENCE BOOKS:

1. Engineering Graphics with Autocad by J. D. Bethune, Prentice Hall, 2007.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS) : NIL

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NIL

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	60
End Semester Test	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Lab Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Lab Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	√	√	√	√
Semester End Examination	√	√	√	√

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

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

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	2	2		2				2		2	2	2	2
CO2	3	3	2		2				2		2	2	2	2
CO3	3	3	3	2	2			2	2		2	2	2	2
CO4	2	2	2	2	3			2	3	2	2	2	2	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD3
CO2	CD3
CO3	CD3
CO4	CD3

COURSE INFORMATION SHEET
Environmental Science

Course code: CE24101
Course title: Environmental Science
Pre-requisite(s): NA
Co- requisite(s): NA
Credits: 3 L:3 T:0 P:0
Class schedule per week: 2
Class: B.Tech.
Semester / Level: 1st Semester/1
Branch: ALL
Name of Teacher:

COURSE OBJECTIVES

This course enables the students to:

1.	To develop basic knowledge of ecological principles and their applications in environment.
2.	To identify the structure and composition of the spheres of the earth, the only planet sustaining life.
3.	To analyse, how the environment is getting contaminated and probable control mechanisms for them.
4.	To generate awareness and become a sensitive citizen towards the changing environment.

COURSE OUTCOMES (COs)

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

CO1	Able to explain the structure and function of ecosystems and their importance in the holistic environment.
CO2	Able to identify the sources, causes, impacts and control of air pollution
CO3	Able to distinguish the various types of water pollution happening in the environment and understand about their effects and potential control mechanisms.
CO4	Able to judge the importance of soil, causes of contamination and need of solid waste management.
CO5	Able to know the impacts of noise pollution and its management.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I: Ecosystem and Environment Concepts of Ecology and Environmental Science, ecosystem: structure, function and services, Biogeochemical cycles, energy and nutrient flow, ecosystem management. Concept of Biodiversity.	6
Module – II: Air Pollution Structure and composition of unpolluted atmosphere, classification of air pollution sources, types of air pollutants, effects of air pollution, monitoring of air pollution, Air pollution control and management.	6

Module – III: Water Pollution Water Resource; Water Pollution: types and Sources of Pollutants; effects of water pollution; Water quality monitoring, Water quality index, water and wastewater treatment: primary, secondary and tertiary.	6
Module – IV: Soil Pollution and Solid Waste Management Soil profile, soil properties, soil pollution, and Municipal solid waste management. MSW – Functional elements of MSW.	6
Module – V: Noise Pollution Noise pollution: introduction, sources, outdoor and indoor noise propagation, Effects of noise on health, criteria noise standards and limit values, Noise measurement techniques, prevention and control of noise pollution.	6

TEXTBOOKS:

1. A, K. De. (3rd Ed). 2008. Environmental Chemistry. New Age Publications India Ltd.
2. R. Rajagopalan. 2016. Environmental Studies: From Crisis to Future by, 3rd edition, Oxford University Press.
3. Eugene P. Odum. 1971. Fundamentals of Ecology (3rd ed.) -. WB Sunders Company, Philadelphia.
4. C. N. Sawyer, P. L. McCarty and G. F. Parkin. 2002. Chemistry for Environmental Engineering and Science. John Henry Press.
5. S.C. Santra. 2011. Environmental Science. New Central Book Agency.

REFERENCE BOOKS:

1. D.W. Conell. Basic Concepts of Environmental Chemistry, CRC Press.
2. Peavy, H.S, Rowe, D.R, Tchobanoglous, G. Environmental Engineering, Mc-Graw - Hill International
3. G.M. Masters & Wendell Ela. 1991. Introduction to Environmental Engineering and Science, PHI Publishers.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS): NA

POS MET THROUGH GAPS IN THE SYLLABUS: NA

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: NA

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher’s assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internet

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	PSO1	PSO2	PSO3
CO1	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**			
CO2	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**			
CO3	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**			
CO4	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**			
CO5	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2
CO2	CD1, CD2
CO3	CD1, CD2
CO4	CD1, CD2
CO5	CD1, CD2

COURSE INFORMATION SHEET

Workshop Practice

Course Code: **PE24102**
Course Title: **Workshop Practice**
Pre-requisite(s): **None**
Co-requisite(s): **None**
Credits: **1 (L:0 T:0 P: 2)**
Class schedule per week: **2**
Class: **B.Tech.**
Semester / Level: **SECOND**
Branch: **Production and Industrial Engineering**
Name of Teacher:

Course Objectives:

This course enables the students to:

1	Familiarize with the basics of manufacturing processes.
2	Impart knowledge and skill to use tools, machines, equipment, and measuring instruments.
3	Practice on manufacturing of components using workshop trades.
4	Educate students on the safe handling of machines and tools.
5	Exercise individual as well as group activity with hands-on training in different workshop trades.

Course Outcomes:

At the end of the course, a student should be able to:

CO1	Be conversant with the basic manufacturing processes.
CO2	Identify and apply suitable tools and instruments for carpentry, foundry, welding, fitting, and conventional and modern machining.
CO3	Manufacture different components using various workshop trades.
CO4	Take safety and precautionary measures for self and machines during operations.
CO5	Develop skills to work as an individual or in a team during trade practices.

SYLLABUS

LIST OF EXPERIMENTS	(NO. OF PRACTICAL HOURS)
1. CARPENTRY SHOP **EXPERIMENT-I: Carpentry Tools and Instruments** **Objective**: To study the various tools, instruments, and equipment used in carpentry practice.	2
2. CARPENTRY SHOP **EXPERIMENT-II: Carpentry Practice** **Objective:** To perform the carpentry work by making a wooden job using different tools.	2
3. FOUNDRY SHOP **EXPERIMENT-I: Green Sand Moulding** **Objective:** To get acquainted with various tools and equipment used in making green sand mould (to practice green sand mould making with single-piece patterns).	2
4. FOUNDRY SHOP **EXPERIMENT-II: Aluminium Casting** **Objective:** To get acquainted with melting and pouring metal in a mould (given two-piece patterns of handle) and to make aluminium casting.	2

5. WELDING SHOP **EXPERIMENT-I: Manual Metal Arc Welding** **Objective:** To study arc welding processes including arc welding machines (AC & DC), electrodes and equipment. To join two pieces of given metal by the arc welding process.	**2**
6. WELDING SHOP **EXPERIMENT-II: Gas Welding** **Objective:** To study gas welding processes, including types of flames produced, filler metals and fluxes, etc. To join two pieces of given metal by the gas welding process.	**2**
7. FITTING SHOP **EXPERIMENT-I: Fitting Tools and Measuring Instruments** **Objective**: To study the various tools used in the fitting shop and perform fitting operations (like marking, chipping, hack-sawing, filing, drilling, etc.)	**2**
8. FITTING SHOP **EXPERIMENT-II: Fitting Assembly Practice** **Objective:** To make a job clamping plate as per the given drawing by fitting operations and to check for its assembly with a given component.	**2**
9. MACHINE SHOP **EXPERIMENT – I: Centre Lathe Machine** **Objective**: To study lathe machine and to machine a given job on the center lathe as per drawing.	**2**
10. MACHINE SHOP **EXPERIMENT-II: Shaper Machine** **Objective:** To study the Shaper machine and to machine a given job on the shaper as per drawing.	**2**
11. MODERN MACHINE SHOP **EXPERIMENT – I: CNC Lathe Machine** **Objective**: To provide an introduction to the functionality and operation of the CNC Lathe Machine through practical demonstration.	**2**
12. MODERN MACHINE SHOP **EXPERIMENT-II: CNC Surface Grinding Machine** **Objective:** To provide an introduction to the functionality and operation of the CNC Surface Grinding Machine through practical demonstration	**2**

Books recommended:

TEXT BOOK

1. S K Hajra Choudhury, A K. Hajra, “Elements of Workshop Technology: Vol- I and Vol -II”, Media Promotors Pvt Ltd. **(T1)**
2. B S Raghuwanshi, "A course in Workshop Technology", Dhanpat Rai Publications. **(T2)**

REFERENCE BOOK

1. P.N. Rao, “Manufacturing Technology Vol-1and Vol-II”, Tata McGraw Hill. **(R1)**
2. Kalpakjian, "Manufacturing Engineering and Technology", Pearson. **(R2)**

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/Seminars	
CD3	Laboratory experiments/teaching aids	√
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	
CD7	Simulation	√

Course Evaluation:

Direct Assessment-

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	**% Distribution**
Day to day performance & Lab files	30
Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Quiz 2	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	√	√	√	√	√
Examination: Experiment Performance	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Course Outcome

Mapping of Course Outcomes (COs) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs**											**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CO1	3	2	1	0	1	1	1	1	1	1	2	3	2	2
CO2	2	3	2	1	3	1	1	1	2	2	2	3	2	3
CO3	2	2	3	2	3	1	1	2	2	2	2	2	2	3
CO4	1	1	2	1	2	2	3	1	1	1	2	1	1	2
CO5	1	1	2	0	1	0	1	3	3	3	2	2	2	2

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

Mapping Between Course Outcomes (COs) and Course Delivery Method

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

COURSE INFORMATION SHEET

Mathematics II

Course Code: MA24103
Course Title: Mathematics II
Pre-requisite(s): Mathematics - I
Co- requisite(s): --
Credits: 4 L: 3 T: 1 P: 0
Class schedule per week: 4
Class: B.Tech.
Semester / Level: II/1
Branch: All
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	various methods to solve linear differential equations of second and higher order
2.	special functions viz. Legendre's and Bessel's and different properties associated with them
3.	diverse mathematical techniques for solving partial differential equations of first order, along with their applications in wave and heat equations using Fourier series
4.	the theory of functions of a complex variable, complex differentiation and integration
5.	about random variables and elementary probability distribution

COURSE OUTCOMES (COs)

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

CO1	investigate the occurrence of ordinary differential equations in real-life problems and identify the suitable methods available for their solutions.
CO2	develop skills to solve and implement various forms of differential equations and special functions in diverse domains.
CO3	learn to solve various forms of partial differential equations arising in real-world.
CO4	gain an understanding of complex variable functions and their properties in science and engineering.
CO5	comprehend and apply the concept of probability distributions in solving problems related to uncertainty.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Ordinary Differential Equations – I Linear differential equations, Wronskian, Linear independence and dependence of solutions, Linear differential equations of 2^{nd} and higher order with constant coefficients, Operator method, Euler – Cauchy's form of linear differential equation, Method of variation of parameters.	**9**
Module – II Ordinary Differential Equations – II Ordinary and singular points of differential equation, Power and Frobenius' series solutions (root differ by non integer and equal roots). Bessel's differential equation, Bessel function of first kind and its important properties. Legendre's differential equation, Legendre's polynomial and its important properties.	**9**
Module – III Fourier series and Partial Differential Equations Fourier series: Euler formulae for Fourier series, Half range Fourier series. Partial Differential Equations: Method of separation of variables and its application in solving one dimensional wave and heat equations.	**9**

Module – IV Complex Variable-Differentiation & Integration Function of a complex variable, Analyticity, Analytic functions, Cauchy – Riemann equations. Cauchy's theorem, Cauchy's Integral formula, Taylor and Laurent series expansions. Singularities and its types, Residues, Residue theorem.	**9**
Module – V Applied Probability Discrete and continuous random variables, cumulative distribution function, probability mass and density functions, expectation, variance. Introduction to Binomial, Poisson and Normal Distribution.	**9**

TEXTBOOKS:

1. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. D. G. Zill and W.S. Wright, Advanced Engineering Mathematics, Fourth Edition, 2011.
3. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., McGraw Hill, 2004.
4. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing, 3rd Ed, 2009.
5. R. A. Johnson, I. Miller and J. Freund: Probability and Statistics for Engineers, PHI
6. S. C. Gupta and V. K. Kapoor: Fundamental of Mathematical Statistics, Sultan Chand and Sons

REFERENCE BOOKS:

1. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India, 2009.
2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
3. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
4. G. F. Simmons, Differential Equations with Applications and Historical Notes, TMH, 2nd ed., 2003.
5. P. L. Meyer: Introductory Probability and Statistical Applications, Oxford & IBH.

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
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

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

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	2	1	0	0	0	1	2			
CO2	3	3	2	3	2	1	0	0	1	1	2			
CO3	3	3	2	3	2	1	0	0	1	1	2			
CO4	3	2	2	2	2	1	0	0	1	1	2			
CO5	3	3	2	2	2	1	1	1	1	2	3			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Physics

Course Code: PH24101
Course Title: Physics
Pre-requisite(s): Intermediate Physics and Intermediate Mathematics
Co- requisite(s): Mathematics I
Credits: 4 L: 3 T: 1 P: 0
Class schedule per week: 4
Class: B.Tech.
Semester / Level: I
Branch: All
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students:

1.	The principles of physical optics and basic concept of fiber optics.
2.	Fundamental laws of electromagnetism leading to Maxwell's equations.
3.	The posulates of special theory of relativity, Lorenz transformation equation and their consequences: Einstein energy mass relation and relativistic energy-momentum relation
4.	The limitations of classical physics and basic concepts such as wave-particle duality, and working of quantum mechanics with the help of particles in a box problem
5.	Concepts of stimulated emission and working principle of laser with examples, concepts of nuclear physics and plasma physics

COURSE OUTCOMES (COs)

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

CO1	analyse the intensity variation of light due to polarization, interference and diffraction.
CO2	formulate and solve the problems on electromagnetism
CO3	explain and apply concepts of special theory of relativity and its consequences
CO4	Apply the concepts of quantum mechanics such as wave-particle duality and obtain the solution of simple quantum mechanical problems.
CO5	explain working principle of lasers and to summarize its applications, describe basic concepts of nuclear and plasma physics

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I: **Physical Optics:** Polarization, Malus' Law, Brewster's Law, Double Refraction, Interference in thin parallel films, Interference in wedge-shaped layers, Newton's rings, Fraunhofer diffraction by single slit and double slit. Elementary ideas of fibre optics and application of fibre optic cables	**8**
Module – II: **Electromagnetic Theory:** Gradient, Divergence and Curl, Statement of Gauss theorem & Stokes theorem, Gauss's law, Applications, Concept of electric potential, Relationship between E and V, Polarization of dielectrics and dielctric constant,	**8**

Boundary conditions for E & D, Gauss's law in magnetostatics, Ampere's circuital law, Boundary conditions for B & H, Equation of continuity, Displacement current, Maxwell's equations.	
Module – III: **Special Theory of Relativity:** Introduction, Inertial frame of reference, Galilean transformations, Postulates, Lorentz transformations and its conclusions, Length contraction, time dilation, velocity addition, Mass change, Einstein's mass energy relation.	6
Module – IV: **Quantum Mechanics:** Planck's theory of black-body radiation, Compton effect, Wave-particle duality, De Broglie waves, Davisson and Germer's experiment, Uncertainty principle, Brief idea of Wave Packet, Wave Function and its physical interpretation, Schrodinger equation in one-dimension, free particle, particle in an infinite square well	9
Module – V **Modern Physics:** Laser-Spontaneous and stimulated emission, Einstein's A and B coefficients, Population inversion, Light amplification, Basic laser action, Ruby and He-Ne lasers, Properties and applications of laser radiation, Nuclear Physics: Binding Energy Curve, Nuclear Force, Liquid drop model, Introduction to Shell model, Applications of Nuclear Physics, Concept of Plasma Physics and its applications.	9

TEXTBOOKS:
1. A. Ghatak, Optics, 4th Edition, Tata Mcgraw Hill, 2009
2. Mathew N.O. Sadiku, Elements of Electromagnetics, Oxford University Press, 2001
3. Arthur Beiser, Concept of Modern Physics, 6th edition, Tata McGraw- Hill, 2009
4. F. F. Chen, Introduction to Plasma Physics and controlled Fusion, Springer, Edition 2016.

REFERENCE BOOKS:
1. Fundamentals of Physics, Halliday, Walker and Resnick

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

<u>**DIRECT ASSESSMENT**</u>

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10

Assignment/Quiz	10
Teacher's assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	PSO 1	PSO 2	PSO 3
CO1	**2**	**2**	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**2**			
CO2	**2**	**2**	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**2**			
CO3	**2**	**1**	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**2**			
CO4	**2**	**1**	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**2**			
CO5	**2**	**1**	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**2**			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Physics lab

Course Code: PH24102
Course Title: Physics lab
Pre-requisite(s): Intermediate Physics
Co- requisite(s):
Credits: 1 L: 0 T: 0 P: 2
Class schedule per week: 2
Class: B.Tech.
Semester / Level: I
Branch: All
Name of Teacher:

COURSE OBJECTIVES

This course enables the students to:

1.	Understand the fundamentals of physical measurements and learn to account for inevitable errors in physical measurements.
2.	Understand and verify the basic principles of physics by hands-on experiments and making suitable measurements.
3.	Make electrical connections reliably to form functional circuits for measuring electrical quantities such as voltage, current, resistance, and resistivity
4.	Learn to set up different types of oscillating systems to study their characteristics, viz -a-viz resonant frequency, frequency response, phase relationship, bandwidth, and quality factor
5.	Develop an understanding of optical phenomena like dispersion, interference and diffraction and make measurements on the patterns produced to obtain physical quantities such as wavelength of light and refractive index of transparent materials.

COURSE OUTCOMES (COs)

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

CO1	Make reliable measurements and report results along with errors.
CO2	Wire simple electrical circuits for experimentally determining measurable electrical quantities.
CO3	Build electral and mechanical oscillating systems, characterize them, and make measurements over them.
CO4	Construct setups to produce interference and diffraction patterns and make measurements for determining physical quantities.

SYLLABUS (List of experiments)

1. Error analysis in Physics Laboratory (CO: 1)
2. To determine the frequency of AC mains with the help of a sonometer. (CO:1, 2, 3)
3. To determine the resistance per unit length of a Carey Foster’s bridge wire and resistivity of unknown wire. (CO:1, 2)
4. Measurement of electrical equivalent of heat (CO:1, 2)
5. To determine the wavelength of sodium lines by Newton’s rings method (CO:1, 4)
6. To determine the frequency of tuning fork using Melde’s Experiment (CO:1,3)
7. Measurement of voltage and frequency of a given signal using CRO (CO: 1,2, 3)
8. To determine the emf of a cell using stretched wire potentiometer (CO:1, 2)
9. Determination of refractive index of the material of a prism using spectrometer and sodium

light (CO:1, 4)
10. To study the frequency response of a series LCR circuit (CO:1, 2, 3)
11. To study Lorentz force using Current balance (CO:1,2)
12. To study electromagnetic induction and verification of Faraday's laws. (CO:1,2,3)
13. To measure the wavelength of prominent spectral lines of mercury light by a plane transmission grating. (CO:1, 4)
14. To determine the Planck's constant using photocell and optical wavelength filters. (CO:1, 2)

REFERENCE MATERIALS:
1. Lab manuals (available on department website)

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
Lab Journal	30
Lab quizes	20
Progressive viva	20
End Sem Examination	30

Continuous Internal Assessment	% Distribution
Lab Journal	30
Lab quiz	10
Progressive viva	20

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	Y	Y	Y	Y	Y
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT
1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Introductory lecture by use of boards/LCD projectors
CD2	Laboratory experiments/ teaching aid
CD3	Self- learning such as use of NPTEL materials and internets
CD4	
CD5	
CD6	
CD7	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	2	1	0	1	2	0	0	2	0	0	2			
CO2	2	1	0	1	2	0	0	2	0	0	2			
CO3	2	1	0	1	2	0	0	2	0	0	2			
CO4	2	1	0	1	2	0	0	2	0	0	2			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

COURSE INFORMATION SHEET

Biological Science for Engineers

Course Code:	**BE24101**
Course Title:	**Biological Science for Engineers**
Pre-requisite(s): -	
Co- requisite(s): -	
Credits:	**2 (L:2 T: 0 P: 0)**
Class schedule per week:	**2**
Class:	**B. Tech**
Semester / Level:	**FIRST**
Branch:	**Biotechnology**
Name of Teacher:	

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Understand fundamental concepts of biology relevant to engineering.
2.	Explore the structure and function of biological molecules and cells.
3.	Learn about genetic principles and molecular biology techniques.
4.	Understand the applications of biological science in various engineering fields considering global challenges and ethical considerations.

COURSE OUTCOMES (COs)

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

CO1	Comprehend and apply the fundamental concepts of biological sciences in the context of engineering.
CO2	Analyze the structure and function of biological molecules and cells and their relevance to engineering solutions.
CO3	Demonstrate understanding of genetic principles and molecular biology techniques and their applications in engineering.
CO4	Apply knowledge of biological sciences to innovate and develop solutions in various engineering domains and critically evaluate the role of biological sciences in addressing global challenges, including ethical and safety considerations.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module I: Introduction to Biological Sciences Overview and importance of biology in engineering, Origin of Life, Cell Theory and Structure.	**6**
Module II: Molecular Biology and Genetics Central Dogma of Molecular Biology, DNA, RNA and Protein structure and function, Mendelian Genetics, rDNA Technology and Genome Editing.	**6**

Module III: Biochemistry Cell Metabolism, Enzymes and Catalysis, Cell Communication and Signalling.	**6**
Module IV: Applications of Biological Sciences in Engineering Biomaterials, Bioinformatics, Biosensors and Bioelectronics (Biological Sensors-Ear & Eye), Synthetic Biology, Nanobiotechnology.	**6**
Module V: Global Challenges and Ethical Considerations Convergence of AI and Biology, Climate change and food security, Biosafety and Biohazards, Ethical Considerations.	**6**

TEXTBOOKS:

1. Lehninger A, Principals of Biochemistry
2. Stryer L, Biochemistry
3. K. Wilson & K.H. Goulding, A biologist's guide to Principles and Techniques of Practical Biochemistry.
4. Biology for Engineers" by Arthur T. Johnson

REFERENCE BOOKS:

1. Purves et al, Life: The Science of Biology
2. R. Dulbecco, The Design of Life.
3. Biological Science Edited by Soper, Cambridge low price edition.
4. Synthetic Biology: A Primer" by Paul S. Freemont and Richard I. Kitney
5. "Introduction to Bioinformatics" by Arthur Lesk Genomes" by T.A. Brown

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
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher's assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher's assessment	**10**

Assessment Components	CO1	CO2	CO3	CO4
Continuous Internal Assessment	√	√	√	√
Semester End Examination	√	√	√	√

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
CO1:	3	3	3	3	1	1	1	2	1	1	1	3	2	3
CO2:	3	3	3	3	1	1	1	2	1	1	1	3	3	3
CO3:	1	3	3	3		1	1	1		1	1	2	3	3
CO4:	2	2	2	2		2	2	2		1	1	3	2	3

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3
CO4	CD1, CD2, CD3

COURSE INFORMATION SHEET

Programming for Problem Solving

Course Code: CS24101
Course Title: Programming for Problem Solving
Pre-requisite(s): School-level mathematics and Science
Co- requisite(s):
Credits: L: 3 T: 1 P:0
Class schedule per week: 4
Class: UG
Semester / Level: II
Branch: ALL
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	Develop Programming Skill.
2.	Understand the fundamental Concepts of Coding
3.	Learn how to Debug Programs
4.	Convert Problems to Programs

COURSE OUTCOMES (COs)

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

CO1	Formulate Algorithms for arithmetic and logical problems.
CO2	Translate the algorithms to programs.
CO3	Test and execute the programs and correct syntax and logical errors.
CO4	Apply programmatic skills for solving scientific problems.
CO5	Decompose problems into functions and structured programming.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I Representation of an Algorithm: Flowchart/Pseudo code with examples. From algorithms to programs: source code, variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.	**6**
Module – II Structure of a C program, variables and data types, Operators – precedence and associativity, Evaluating expressions, Basic I/O – use of printf, scanf, getchar etc. and format specifiers, Conditional Branching statements – If, If - else, If-else- if, switch case, Writing nested conditional statements.	**8**
Module – III Iterative programming structures – for loops, while loops, do while loops. Understanding break and continue and their usage. Writing Nested loops, Arrays – creation and usage, Strings and string handling.	**8**

Module – IV Functions (including using built in libraries), Parameter passing in functions, call by value, Recursion, as a different way of solving problems, Nested function calls. Understanding scope and lifetime of a variable.	**8**
Module – V Structures - Defining structures, Accessing structures elements, Creating an array of Structures, Nested structures. Some advanced concepts – typedef, enum, macros. An introduction to pointers – understanding, creating pointers and accessing variables using pointers. Passing arrays to functions: idea of call by reference, passing parameters to main.	**10**

TEXTBOOKS:

1. Let us C, Yashwant Kanetkar, 18th Edition, BPB Publications
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
4. R.G.Dromey, How to Solve it by Computer, Pearson Education

REFERENCE BOOKS:

- Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

1. The syllabus focused on the concepts and basics of Program writing skills.
2. Industry often requires debugging of their existing programs/software compare to the new program, which is a knowledge beyond the basics, including real-world software (collection of programs) experience.
3. More memory management practices, file handling and library functions

POS MET THROUGH GAPS IN THE SYLLABUS: YES [PO1-PO5 & PO10-PO12]

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN:

File Handling with memory management, pre processor directives, Graphics, Data Arrangement, Task scheduling and assembly level programs.

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: YES [PO1-PO5]

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination	25
End Sem Examination	50
Quiz	10
Assignment	10
Teacher’s assessment	05

Continuous Internal Assessment	**% Distribution**
Mid Sem Examination	50
Quiz and assignment	40
Teacher’s assessment	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	Y	Y	Y	Y	
Semester End Examination	Y	Y	Y	Y	Y

INDIRECT ASSESSMENT

- **Student Feedback on Course Outcome**
- **Student Feedback on Faculty/Content Delivery**
- **Student Feedback on Evaluation Procedures**

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/Assignments
CD3	Seminars/ Quiz (s)
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Self-Learning, Group Study, Coding Contest

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**	**3**	**3**	**2**	**0**	**1**	**2**	**2**	**2**			
CO2	**3**	**3**	**3**	**3**	**3**	**2**	**0**	**1**	**2**	**2**	**2**			
CO3	**3**	**3**	**3**	**3**	**3**	**2**	**0**	**1**	**2**	**2**	**2**			
CO4	**3**	**3**	**3**	**3**	**3**	**2**	**0**	**1**	**2**	**2**	**2**			
CO5	**3**	**3**	**3**	**3**	**3**	**2**	**0**	**1**	**2**	**2**	**2**			

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3
CO2	CD3, CD5
CO3	CD3, CD5, CD7
CO4	CD2, CD3, CD4, CD6, CD7
CO5	CD1, CD3, CD5, CD7

COURSE INFORMATION SHEET

Programming for Problem Solving Laboratory

Course Code: CS24102
Course Title: Programming for Problem Solving Laboratory
Pre-requisite(s):
Co- requisite(s): Programming for Problem Solving (CS24101)
Credits: L: T: P:
Class schedule per week:
Class:
Semester / Level: Ist, 1
Branch:All
Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students:

1.	The basics of computer programming.
2.	Ideas about converting problem statements to programs.
3.	Ideas about handling data at scale.
4.	Knowledge about accessing the memory of a computer using code.

COURSE OUTCOMES (COs)

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

CO1	Write basic programs using fundamental control structures.
CO2	Demonstrate the accessing of arrays.
CO3	Write simple functions to modularize programs.
CO4	Work with user defined data types.
CO5	Access memory using pointers and manipulate data using them.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Programming using basic control structures including sequential programs, selection logic including nested selection logic switch structures.	3

Module – II **Write programs using basic iterative structures, nested iterations, programs using looping with selections, controlled loop exit, Manipulating n-dimensional arrays.**	**3**
Module – III **Modularize programs using functions, functions calling functions, elementary string handling programs, recursive programs.**	**3**
Module – IV **Programs using user defined data types, arrays of user defined data types, basic usage of pointers, functions and pointers.**	**3**
Module – V **Advanced usage of pointers, string handling using pointers, parameterizing main, manipulating arrays using pointers.**	**3**

TEXTBOOKS:

1) Programming in C, Yashwant Kanetkar, BPB Publications.

REFERENCE BOOKS:

1) C Programming, Byron Gottfried, Addison Wesley Press

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

1) Elementary file handling

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
Laboratory Quiz	20
Laboratory Performance	30
Laboratory Viva	20
Continuous Evaluation	30

INDIRECT ASSESSMENT

1. **Student Feedback on Course Outcome**

COURSE DELIVERY METHODS

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	1	2			3	1					
CO2	3	3	2	1	2			3	1					
CO3	3	3	2	1	2			3	1					
CO4	3	3	2	1	2			3						
CO5	3	2	2	1	2			1						

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

COURSE INFORMATION SHEET

Basics of Electrical Engineering

Course Code: EE24101

Course Title: Basics of Electrical Engineering

Pre-requisite(s):

Co- requisite(s): Basic Sciences

Credits: 3 L: 2 T: 1 P: 0

Class schedule per week: 03

Class: B.Tech.

Semester / Level: I (II)/01

Branch: All

Name of Teacher:

COURSE OBJECTIVES

This course envisions to impart to students to:

1.	realize the electrical signals, elements, and their properties.
2.	understand the mathematical representation of AC, DC signals and theorems/laws for solving electrical circuits with variations of voltage and frequency.
3.	perceive the 3-phase AC signal representation and 3-phase circuit analysis for balanced and unbalanced condition.
4.	understand the characteristics of magnetic material and analysis of magnetic circuits.

COURSE OUTCOMES (COs)

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

CO1	explain the voltage, current signals and their characteristics in electrical circuit elements.
CO2	apply the theorems/laws for electrical circuit analysis.
CO3	solve the electrical circuits for variable voltage and frequency to observe the resonance, power and power factor in the electric circuit.
CO4	analyze the 1-phase and 3-phase AC balanced and unbalanced circuits
CO5	apply the concept of magnetic circuits for magnetic circuit analysis.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I **Introduction:** Importance of Electrical Engineering in day-to-day life, Electrical elements, properties (linear, non-linear, unilateral, bilateral, lumped and distributed, etc.) and their classification, Ideal and Real Sources, Source Conversion, Star-Delta conversion, KCL and KVL, Mesh current and Nodal voltage method.	**8**
Module – II **D.C. Circuits**: Steady state analysis with independent and dependent sources; Series and Parallel circuits. **Circuit Theorems:** Superposition, Thevenin's, Norton's, and Maximum Power Transfer theorems for Independent and Dependent Sources applied to DC circuits.	**8**
Module – III **Single-phase AC Circuits:** Common signals and their waveforms, RMS and Average value. Form factor & Peak factor of a sinusoidal waveform. **Series Circuits:** Impedance of Series circuits. Phasor diagram. Active Power. Power factor. Power triangle. **Parallel Circuits:** Admittance method, Phasor diagram, Power and Power factor Power triangle, Series-parallel Circuit, Power factor improvement, Circuit Theorems applied to AC circuits. **Series and Parallel Resonance**: Resonance curve, Q–factor, Dynamic Impedance, and Bandwidth.	**12**
Module – IV **Three-Phase AC Circuits:** Importance and use of a 3-phase network, types of 3-phase connections- Star and Delta, Line and Phase relations for Star and Delta connection, Phasor diagrams, Power relations, analysis of balanced and unbalanced 3-phase circuits, Measurement of Power in 3-phase star and delta network.	**6**
Module – V **Magnetic Circuits:** Introduction, Series-parallel magnetic circuits, Analysis of Linear and Non-linear magnetic circuits, Energy storage, A.C. excitation, Eddy currents and Hysteresis losses. **Coupled Circuits:** Dot rule, Self and mutual inductances, Coefficient of coupling, working of transformer.	**6**

TEXTBOOKS:

1. W. H. Hayt, Jr J. E. Kemmerly and S. M. Durbin, Engineering Circuit Analysis, 7th Edition TMH, 2010.

2. Hughes, Electrical Technology, Revised by McKenzie Smith, Pearson.
3. Fitzgerald and Higginbotham, Basic Electrical Engineering, McGraw Hill Inc, 1981

REFERENCE BOOKS:

1. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering, 3rd Edition, TMH, New Delhi, 2009.
2. Electrical Engineering Fundamental, Vincent Del Toro, Prentice Hall, New Delhi.
3. Rajendra Prasad, Fundamentals of Electrical Engineering, 2nd Edition, PHI, New Delhi, 2011.
4. Raymond A. DeCarlo, Prn-Min Lin, Linear Circuit Analysis Time Domain, Phasor and Laplace Transform Approaches, 2nd Edition, Oxford University, 2001
5. Abhijit Chakrabarti, Sudipta Nath, Chandan Kumar Chanda, Basic Electrical Engineering, Tata McGraw Hill Publication, 2009.

GAPS IN THE SYLLABUS (TO MEET INDUSTRY/PROFESSION REQUIREMENTS)

1. Application of principles of magnetic circuits to electrical machines like transformers, generators and motors.
2. Field applications of three phase equipment and circuits in power system.
3. Applications of circuit theorems in electrical and electronics engineering

POS MET THROUGH GAPS IN THE SYLLABUS: 6, 4, 11

TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN

1. Concepts of electric, magnetic and electromagnetic fields.
2. 3 - Φ power generation, transmission, and distribution.
3. Power factor improvement for three phase systems.
4. Utility of reactive power for creation of electric and magnetic fields.

POS MET THROUGH TOPICS BEYOND SYLLABUS/ADVANCED TOPICS/DESIGN: 3, 4, 6.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Quiz (s)	10
Mid Semester Examination	25
End Semester Examination	50
Assignment	10
Teacher Assessment	05

Continuous Internal Assessment	% Distribution
Mid Sem Examination	50
Quiz and assignment	40
Teacher’s assessment	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	🟩	🟩	🟩	🟩	🟩
Semester End Examination	🟩	🟩	🟩	🟩	🟩

INDIRECT ASSESSMENT

1. Student Feedback on Course Outcome

COURSE DELIVERY METHODS

CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Self- learning such as use of NPTEL materials and internets
CD8	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**1**	**3**	**2**	**3**	**1**	**1**	**2**	**3**	**1**	**2**	**1**	**2**	
CO2	**3**	**1**	**3**	**3**	**3**	**1**	**1**	**2**	**3**	**1**	**2**	**3**	**3**	
CO3	**3**	**2**	**3**	**3**	**3**	**1**	**2**	**1**	**3**	**1**	**2**	**3**	**3**	
CO4	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**1**	**3**	**1**	**2**	**3**	**3**	
CO5	**3**	**2**	**1**	**1**	**3**	**1**	**2**	**1**	**3**	**1**	**2**	**3**	**3**	

Grading: No correlation – 0, Low correlation - 1, Moderate correlation – 2, High Correlation - 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD5
CO2	CD1, CD2, CD4, CD5, CD7
CO3	CD1, CD2, CD5, CD7, CD8
CO4	CD1, CD2, CD5, CD7, CD8
CO5	CD1, CD2, CD4, CD5, CD7, CD8

COURSE INFORMATION SHEET

Electrical Engineering Laboratory

Course code: EE 24102

Course Title: Electrical Engineering Laboratory

Pre-requisite(s): Physics, Fundamentals of Mathematics and Electrical Engineering.

Co- requisite(s):

Credits: 01 L: 0 T: 0 P: 2

Class schedule per week: 02

Class: B. Tech

Semester / Level: I (II)/1

Branch: EEE

Name of Teacher

Course Objectives

This course enables the students:

1.	To describe students' practical knowledge of active and passive elements and operation of measuring instruments
2.	To demonstrate electrical circuit fundamentals and their equivalent circuit models for both 1-φ and 3- φ circuits and use circuit theorems
3.	To establish voltage & current relationships with the help of phasors and correlate them to experimental results
4.	1. To conclude performance of 1 – Φ AC series circuits by resonance phenomena 2. To evaluate different power measurements for both 1-φ and 3- φ circuits

Course Outcomes

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

CO1	classify active and passive elements, explain working and use of electrical components, different types of measuring instruments;
CO2	illustrate fundamentals of operation of DC circuits, 1-φ and 3- φ circuits and also correlate the principles of DC, AC 1-φ and 3- φ circuits to rotating machines like Induction motor and D.C machine
CO3	measure voltage, current, power, for DC and AC circuits and also represent them in phasor notations;
CO4	analyze response of a circuit and calculate unknown circuit parameters;
CO5	recommend and justify power factor improvement methods in order to save electrical

LIST OF EXPERIMENTS ***(The experiment list may vary to accommodate recent development in the field)***

EXPERIMENT – 1

Name: - Measurement of low and high resistance of a DC shunt motor

Aim: - (i) To measure low resistance of armature winding of DC shunt motor.

(ii) To measure high resistance of field winding of DC shunt motor.

EXPERIMENT – 2

Name: - AC RLC series circuit

Aim: - To obtain current and voltage distribution in AC RLC series circuit and draw the phasor diagram of voltage distribution.

EXPERIMENT – 3

Name: - Single phase power factor measurement by three voltmeter method

Aim: - To obtain power and power factor of the single-phase load using three voltmeter method and draw the phasor diagram.

EXPERIMENT – 4

Name: - AC RLC parallel circuit

Aim: - To obtain current and voltage distribution in a AC RLC parallel circuit and draw the current phasor diagram.

EXPERIMENT – 5

Name: - Single phase power factor measurement by three Ammeter method

Aim: -To obtain power and power factor of single-phase load using three ammeter method and draw the phasor diagram.

EXPERIMENT – 6

Name: -Study of resonance in a RLC series circuit

Aim: - To obtain the resonance condition in AC RLC series circuit and draw the phasor diagram.

EXPERIMENT – 7

Name: -Three phase Delta connection

Aim: - To obtain the relation between line and phase quantities in a three-phase Delta connected load and obtain the phasor diagram.

EXPERIMENT – 8

Name: - Three phase Star connection

Aim: -To obtain the relation between line and phase quantities in a three-phase Star connected load and draw the phasor diagram.

EXPERIMENT – 9

Name: - Measurement of three phase power by two wattmeter method.

Aim: - To measure the power input to a three-phase induction motor by two-wattmeter method and draw the phasor diagram.

EXPERIMENT – 10

Name: - Verification of superposition and Thevenin's Theorems.

Aim: - (i) To verify Thevenin's Theorem for a given circuit.

(ii) To verify Superposition Theorem for a given circuit.

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

1. Application of principles of magnetic circuits to electrical machines like transformers, generators and motors.
2. Visualize Phase sequence.

POs met through Gaps in the Syllabus: 1, 2, 4, 6.

Topics beyond syllabus/Advanced topics/Design

1. Assignment: Simulation of electrical circuits with dependent/independent sources by various techniques (Mesh current/Node Voltage/Thevenin's theorem/Norton's theorem/Maximum power transfer theorem etc.) using MATLAB/PSIM/C++ software.
2. Active/reactive power calculation for 3 – Φ circuits

POs met through Topics beyond syllabus/Advanced topics/Design: 3, 4, 5, 6.

Mapping lab experiment with Course Outcomes

Experiment	Course Outcomes				
	CO1	CO2	CO3	CO4	CO5
1	3	3	1	1	
2	3	3	3	3	3
3	3	3	3	3	3
4	3	3	3	3	3
5	3	3	3	3	3
6	3	3	3	3	
7	3	3	3	1	
8	3	3	3	1	1
9	3	3	3	2	2
10	3	3	2	2	

MAPPING BETWEEN COURSE OUTCOMES AND POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	1	2	3	3	1	2	1	2	
CO2	3	2	3	2	3	1	2	3	3	1	2	3	3	
CO3	3	2	3	2	3	1	2	3	3	1	2	3	3	
CO4	3	2	3	2	3	1	2	3	3	1	2	3	3	
CO5	3	2	3	2	3	2	2	3	3	1	2	3	3	

Course Delivery methods	
CD1	Laboratory experiments/teaching aids
CD2	Mini projects/Projects
CD3	Tutorials/Assignments
CD4	Self- learning, such as the use of NPTEL materials and the internet

COURSE INFORMATION SHEET
Communication Skills-I

Course Code: HS24131
Course Title: Communication Skills-I
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 1.5 L: 0 T: 0 P: 3
Class schedule per week: 30
Class: UG/PG
Semester / Level: I
Branch: All

COURSE OBJECTIVES

This course envisions imparting students to:

1.	To demonstrate the ability to listen to and comprehend complex speech in English, listen to explanations, descriptions, messages, news stories, opinions, solutions, etc.
2.	To demonstrate the ability to speak effectively in English with peers, teachers and others, handle the various speaking situations in their academic and social sphere with confidence.
3.	To demonstrate the ability to read and analyse functional texts confidently; apply critical thinking, analysis and problem-solving skills to the reading material.
4.	To demonstrate the ability to write messages, personal accounts, critical reviews, short biographies, describe processes, write persuasive essays, etc.
5.	To demonstrate a strong hold on functional grammar which helps them avoid common communication errors.

COURSE OUTCOMES (COs)

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

CO1	Communicate confidently in English with their peers and teachers in the immediate environment and with colleagues, clients, etc., in their future workplaces.
CO2	Apply their learning of English to domain subjects and make presentations, posters, write research papers, lab reports, etc, with confidence.
CO3	Handle communicative situations confidently in their academic life, such as conversations, discussions, interviews, presentations, seminars, webinars, etc.
CO4	Prepare for their future workplaces and their requirements, such as handling team huddles, meetings, phone calls, client visits, field visits, inspections, etc.
CO5	Apply critical thinking abilities to analyse problems, brainstorm solutions, handle situations that require persuasive skills, etc.

SYLLABUS

MODULE	(NO. OF LECTURE /PRACTICAL Hours)
Module – I **Effective Listening:** The importance of listening: Listening for descriptions of people; listening for opinions; listening for complaints; Listening to people making, accepting, and declining requests; Listening to news stories; listening to messages and a podcast; Process of Listening, Types of Listening, Barriers to Effective Listening, Listening at different managerial levels. Listening for information about living abroad; listening to opinions; Listening to complaints; Listening to environmental problems; listening for solutions; Listening to descriptions of important events; listening to regrets and explanations; Listening to explanations; listening for the best solution; Listening to past obstacles and how they were overcome; listening for people's goals for the future.	**6**
Module – II **Speaking with Confidence:** Describing personalities; expressing likes and dislikes; agreeing and disagreeing; complaining; Talking about possible careers; describing jobs; deciding between two jobs; Making direct and indirect requests; accepting and declining requests; Narrating a story; describing events and experiences in the past; Talking about travelling abroad; expressing emotions; describing cultural expectations; giving advice; Describing problems; making complaints; explaining something that needs to be done. Identifying and describing problems; coming up with solutions; Asking about preferences; discussing different skills to be learned; talking about learning methods; talking about life skills; asking for and giving advice or suggestions; talking about things to be accomplished in the future; Describing milestones; describing turning points; describing regrets and hypothetical situations; Describing qualities for success; giving reasons for success; interviewing for a job; talking about ads and slogans; Drawing conclusions; offering explanations; Giving opinions for and against controversial topics; offering a different opinion; agreeing and disagreeing.	**6**
Module – III **Art of Reading:** Reading about unusual social networking sites; Reading about different types of workplaces; Reading about talking to friends about difficult topics; Types of Reading, Methods of Reading, Reading Comprehension. Reading about the reliability of online content; Reading about a problem with a ride-sharing service; Reading about a creative solution to a problem; Reading about different studying styles; Reading about young scientist; Reading about futurists and their predictions for the year 2050; Reading about a conflict and advice on how to fix it; Reading about advertisements; Reading about unexplained events; Reading about a job role; Reading about plagiarism in the digital age.	**6**
Module – IV **Writing Skills:** Writing a description of a good friend; Writing about two career choices; Writing a message with requests; Writing a personal account; Writing a pamphlet for tourists; Writing	**6**

a critical online review; Writing a post on a community website; Writing about a skill; Writing a message of advice; Writing a biography; Writing a message of apology; Writing a TV or web commercial; Writing about a process; Writing a persuasive essay; Writing a personal statement for an application.	
Module – V **Advanced Writing Skills:** Art of condensation: Précis writing, Summary Abstract, Synopsis, Paraphrasing; Paragraph writing; Essay writing: Writing a persuasive essay; Writing a biography; Writing about a process; Writing a personal statement for an application; Writing a critical online review; Writing about a complicated situation; Report writing; Writing technical proposals.	**6**

Textbooks

1	*Interchange 5 edition Level 3,* Jack C. Richards, Jonathan Hull, Susan Proctor, Cambridge University Press. Components: Student's Book with online self-study (print/online bundle) CEFR level: B1

Reference Books

1	Communication Skills (2015) IInd edition, Sanjay Kumar & Pushp Lata, Oxford University Press
2	Business Correspondence and Report Writing, (2020)VIth edition, R.C. Sharma, Krishna Mohan, Virendra Singh Nirban, McGraw Hill
3	Communication for Business, (2010) IVth edition, Shirley Taylor, V. Chandra, Pearson
4	Basic Business Communication-(2004). Lesikar I Flatley, McGraw Hill
5	Business Communication Today, (2017), Bovee, Thill and Chatterjee, Pearson

Direct Assessment

Tools	**% Contribution of Assessment**
End Semester Evaluation	**100**

CO-PO Mapping

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1								✓	✓		✓
CO2		✓		✓					✓		
CO3		✓		✓					✓		
CO4			✓						✓	✓	
CO5							✓	✓	✓		✓

COURSE INFORMATION SHEET
Communication Skills-II

Course Code: HS24133
Course Title: Communication Skills-II
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 1.5 L: 0 T: 0 P: 3
Class schedule per week: 30
Class: UG/PG
Semester / Level: I
Branch: All

COURSE OBJECTIVES

This course envisions imparting students to:

1.	To analyze and demonstrate writing and speaking processes through invention, organization, drafting, revision, editing, and presentation.
2.	To understand the importance of specifying audience and purpose and to select appropriate communication choices.
3.	To interpret and appropriately apply modes of expression, i.e., descriptive, expositive, narrative, scientific, and self-expressive, in written, visual, and oral communication.
4.	Participate effectively in groups emphasizing listening, critical and reflective thinking, and responding.
5.	To develop the ability to research and write a documented paper and/or to give an oral presentation.

COURSE OUTCOMES (COs)

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

CO1	Apply business communication strategies and principles to prepare effective communication for domestic and international business situations.
CO2	Utilize analytical and problem-solving skills appropriate to business communication.
CO3	Participate in team activities that lead to the development of collaborative work skills.
CO4	Select appropriate organizational formats and channels used in developing and presenting business messages.
CO5	Communicate via electronic mail, Internet, and other technologies and deliver an effective oral business presentation.

SYLLABUS

MODULE	**(NO. OF LECTURE /PRACTICAL Hours)**
Module – I **Building a Business Vocabulary:** Vocabulary related to company culture, Phrasal verbs Board, bottom line, revenues, etc.; Words related to leadership skills: founder, etc.; Types of management; Abbreviations; Meeting related vocabulary; Vocabulary related to submitting tenders; Pricing Dedicated, resources, etc.; Verb–noun collocations; Linking words and phrases Existing, identify, etc.; Brand-building, etc.; Types of advertising Households, etc.; Synonyms for increase and	**6**

decrease; Solicit, risk-averse, etc.; Phrasal verbs and expressions like go bust, stock price, etc.; Vocabulary from profit-and-loss account; and balance sheet; Theatre vocabulary Break down, running costs, etc; Bank charges, bookkeeping, etc.; Formal expressions; Types of workers; Ways of working; Phrases for negotiating; Benefits, premise, etc.; Adverbial phrases; Acquisitions, year on year, etc.; Adjectives and adverbs of frequency; Discourse markers for short talks.	
Module – II **Listening at the Workplace:** Listening to descriptions of company culture; Listening to a talk on leaders and managers; Advice for communicating effectively with colleagues; Listening to a talk on Customer Relationship Management; Listening to a presentation; Listening to a talk on effectiveness of advertising; Listening to a talk on sales activities; Listening to a sales pitch; Listening to a sales forecast; Listening to a business conversation; Listening to people talk about their jobs; Listening to interviews with production managers; Listening to staff complaints and demands; Listening to a talk on risk in business.	**6**
Module – III **Oral communication at the workplace:** Describing company culture; Talking about good leaders; Communicating in meetings; Discussing customer-supplier relationships; Presenting information from charts; Presenting from a text; Cost-effective advertising; How to advertise software; Using the Internet for advertising; Finding out about work problems; Making a sales pitch; Negotiation, problems and advice; Talk: teleworking, etc.; Talking about your present job; Describing charts; Presentations on productivity; Negotiating an agreement; Describing the company you work for; Useful hints for making presentations; Making a presentation; Discussion on staff retention, market share, etc.	**6**
Module – IV **Reading for Business:** Reading internal messages (memo, email, note, notice); Reading a summary of action points; Reading a business forecast; Reading articles on Customer Relationship Management; Reading about how a company prepares tenders; Reading a proposal; Reading extracts on measuring the impact of advertising; Reading a brief sales report; Reading a productivity report; Reading a memo from a CEO; Reading a business letter.	**6**
Module – V **Business Correspondence:** Replying to messages; Writing and replying to a memo, email or notice; A proposal for investigating new markets; A report on advertisers and target audiences; A sales report based on a chart; Report on a sales event for a product launch; A proposal for sponsoring an arts or sports event; Letter complaining about late payment; Email summarising results of negotiation; Short report on stress and absenteeism; Report on changes to company organization; Memo summarising agreement; Proposal to give your company a more ethical image; Letter to prospective customers; Letter expressing interest in business approach.	**6**

Textbooks

1	Empower, Second Edition, Students book, C1 advanced (2010), Adrian Doff, Craig Thaine, Herbert Puchta, Jeff Stranks, Peter Lewis-Jones, Cambridge University Press and Assessment.

Reference Books

1	Communication Skills (2015) IInd edition, Sanjay Kumar & Pushp Lata, Oxford University Press
2	Business Correspondence and Report Writing, (2020)VIth edition, R.C. Sharma, Krishna Mohan, Virendra Singh Nirban, McGraw Hill
3	Communication for Business, (2010) IVth edition, Shirley Taylor, V. Chandra, Pearson
4	Basic Business Communication-(2004). Lesikar I Flatley, McGraw Hill
5	Business Communication Today, (2017), Bovee, Thill and Chatterjee, Pearson

Direct Assessment

Tools	**% Contribution of Assessment**
End-semester Evaluation	**100%**

CO-PO Mapping

Course Outcomes (COs)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1								✓	✓		✓
CO2		✓		✓					✓		
CO3		✓		✓					✓		
CO4			✓						✓	✓	
CO5							✓	✓	✓		✓

COURSE INFORMATION SHEET
Basic Electronics

Course code: EC24101
Course title: Basic Electronics
Pre-requisite(s): N/A
Co- requisite(s): N/A
Credits: L: 2 T: 1 P: 0 C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: 0I/01
Branch: ALL B.TECH.

Course Objectives

This course enables the students:

1.	To understand PN Junction, diodes and their applications.
2.	To comprehend BJT and the bias configurations.
3.	To understand operating principles of FETs
4.	To understand op amp and its applications.
5.	To apprehend number system, Logic Gates and Boolean algebra.

Course Outcomes

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

CO1	Understand the characteristics of electronic devices like PN-diode, BJT, JFET and MOSFET
CO2	Classify and analyze the various circuit configurations of BJTs and MOSFETs.
CO3	Analyze the characteristics of operational amplifier.
CO4	Design electronic circuits using diodes, transistors, op-amp and logic gates for analog and digital applications.
CO5	Solve day-to-day life problems using electronic circuits.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I **Diodes and Applications:** Introduction to semiconductor materials, PN junction diode, barrier potential, depletion layer width, junction capacitance, diode current equation, I-V plot, diode-resistance, temperature dependence, breakdown mechanisms, Zener diode – operation and applications, Diode as a Rectifier: Half Wave and Full Wave Rectifiers with and without C-Filters.	**8**

Module – II **Bipolar Junction Transistors (BJT):** Basic operation of PNP and NPN Transistors, Input and Output Characteristics of CB, CE and CC Configurations. Transistor biasing: operating point, Fixed bias, emitter bias, voltage divider bias, stability factor, small signal analysis (h-parameter model) of CE configuration.	**8**
Module – III **Field Effect Transistors:** JFET: Principle of operation, transfer characteristics, MOSFET: Operation of N-MOS, P-MOS, enhancement and depletion type, transfer characteristics, CS biasing of JFET and MOSFET.	**8**
Module – IV **Operational Amplifiers:** Introduction of Operational Amplifier, Characteristics of Operational Amplifier, Differential Amplifier, CMRR, Slew Rate, input and output offset voltages, Inverting and non-inverting amplifiers, Summing Amplifier, Difference amplifier, Differentiator and Integrator.	**8**
Module – V **Boolean Algebra and Logic Gates:** Boolean Algebra, Boolean operators, Truth table of different digital logic gates (AND, OR, NOT, NAND, NOR, EXOR, EX-NOR), application of diode for design of logic gates, realization of logic gates using universal gates, adder, subtractor.	**8**

Textbooks:

1. Millman J., Halkias C.C. “Integrated Electronics: Analog and Digital Circuits and Systems”, Tata McGraw-Hill.
2. Boylstead R.L., Nashelsky L., “Electronic Devices and Circuit Theory”, Pearson Education, Inc, 11/e.
3. Mano M.M., Michael D. Ciletti, “Digital Design”, Pearson Education, Inc, 5/e, 2011.

Reference books:

1. Millman J., Halkias C.C., Parikh Chetan, “Integrated Electronics: Analog and Digital Circuits and Systems”, Tata McGraw-Hill, 2/e.
2. Millman J., Halkias C.C., Satyabrata Jit, “Millman’s Electronic Devices and Circuits”, Tata McGraw-Hill, 3/e.
3. Albert Paul, Malvino, David J. Bates, “Electronic principles”, McGraw-Hill, 8/e, 2015.

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 and Evaluation Procedure

Direct Assessment

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

Indirect Assessment

1. Student Feedback on Faculty
2. 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	1	2	3
CO1	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO2	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO3	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO4	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO5	3	3	1	2	3	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	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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

Basic Electronics Lab

Course code: EC24102
Course title: Basic Electronics Lab
Pre-requisite(s): N/A
Co- requisite(s): N/A
Credits: L: 0 T: 0 P: 2 C:1
Class schedule per week: 02
Class: B. Tech.
Semester / Level: I/01
Branch: ALL B.TECH.

Course Objectives

This course enables the students:

1.	To measure magnitude, time-period, frequency, phase of signals using CRO
2.	To know PN junction characteristics and its applications
3.	To understand the working of transistor amplifier
4.	To understand the working of operational amplifier and circuits
5.	To realize logic gates and implement simple Boolean expression

Course Outcomes

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

CO1	Familiarize with electronics components like diode, transistors, ICs
CO2	Make use of measuring instruments and function generators
CO3	Verify characteristics of diodes, transistors and op-amp
CO4	Design electronic circuits using diodes, transistors, op-amp for analog applications
CO5	Design electronic circuits using logic gates for digital applications

List of Experiments

Experiment No.	**Name of the Experiments**
(A) HARDWARE BASED EXPERIMENTS	
1.	**MEASURMENTS 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.	**HALF-WAVE AND FULL WAVE RECTIFIER CIRCUITS** 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.
3.	**COMMON EMITTER (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.
4.	**INVERTING OPERATIONAL AMPLIFIER (OP-AMP)** AIM: To design the inverting operational amplifier using IC741 OP-AMP and find its Gain and Frequency Response.
5.	**DIFFERENTIAL AMPLIFIER** AIM-1: To design common mode and differential mode circuit using IC741 OP-AMP AIM-2: To obtain common mode gain and differential mode gain and calculate CMRR.
6.	**REALIZATION OF 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).
(B) SOFTWARE BASED EXPERIMENTS	
1.	**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.
2.	**ZENER DIODE CHARACTERISTICS** 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.
3.	**FIELD EFFECT TRANSISTOR CHARACTERISTICS** AIM-1: To determine the output and transfer characteristics of JFET. AIM-2: To measure the voltage, gain of JFET.
4.	**NON-INVERTING OPERATIONAL AMPLIFIER (OP-AMP)** AIM: To design the non-inverting operational amplifier using IC741 OP-AMP and find its Gain and Frequency Response.
5.	**DIFFERENTIATOR AND INTEGRATOR CIRCUITS USING OP-AMP** AIM-1: To design differentiator circuit using IC741 OP-AMP and observe waveforms. AIM-2: To design integrator circuit using IC741 OP-AMP and observe waveforms.
6.	**IMPLEMENTATION OF BOOLEAN FUNCTION** AIM-1: To understand the AND Gate IC (IC 7408) and OR Gate IC (IC 7432) AIM-2: To implement a given Boolean expression using logic gate ICs.

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.

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

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

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

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**	**1**	**2**	**3**
CO1	3	3	1	2	3	1	1	2	2	2	2	2	2	1
CO2	3	3	1	2	3	1	1	2	2	2	2	2	2	1
CO3	3	2	1	2	3	1	1	2	2	2	2	2	2	1
CO4	3	3	1	2	3	1	1	2	2	2	2	2	2	1
CO5	3	2	1	2	3	1	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
Electronic Devices

Course code: EC24201
Course Title: Electronic Devices
Pre-requisite(s): Basic Electronics
Co-requisite(s): NA
Credits: L: 3 T: 1 P: 0 C: 4
Class schedule per week: 04
Class: B. Tech.
Semester / Level: III/02
Branch: ECE

Course Objectives

This course enables the students to:

1.	Understand Atoms, Electrons, Energy Bands and Charge Carriers in Semiconductors.
2.	Grasp the impact of Excess Carriers in Semiconductors.
3.	Appraise and analyze the characteristics of PN Junction.
4.	Evaluate the characteristics of Junction Diodes.
5.	Comprehend the characteristics of Bipolar Junction Transistors (BJTs) and Field-Effect Transistors.

Course Outcomes

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

CO1	Describe the basics of semiconductor materials and electron devices.
CO2	Analyse the characteristics of semiconductors.
CO3	Illustrate and characterize PN Junction.
CO4	Illustrate and characterize PN Junction diodes.
CO5	Schematize the structure of BJTs and FETs and characterize them.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I **Basics of Semiconductors:** Atoms, Electrons, Energy Bands and Charge Carriers in Semiconductors, Bonding Forces and Energy Bands in Solids, Direct and Indirect Semiconductors, Effective Mass.	**8**
Module – II **Carrier Concentration and Excess Carriers in Semiconductors:** Fermi level, Temperature Dependence of Carrier Concentrations, Conductivity and Mobility, High-Field Effects, The Hall Effect. Excess Carriers: Optical Absorption, Carrier Lifetime and Photoconductivity, Diffusion and Drift of Carriers.	**8**

Module – III **PN Junction:** PN Junction: Built-in Fields, Diffusion and Recombination; the Continuity Equation, Steady State Carrier Injection; Diffusion Length, the Haynes–Shockley Experiment. Charge at Junction, Contact Potential, Capacitance of p-n Junctions, Reverse-Bias Breakdown.	**8**
Module – IV **Junction Diodes:** Junction Diodes: Varactor Diode, Effects of Contact Potential on Carrier Injection, Recombination and Generation in Transition Region, Metal–Semiconductor Junctions, Step Recovery Diodes, IMPATT diode, Tunnel Diode, Gunn Diode, PIN diode, LED.	**8**
Module – V **Bipolar Junction Transistors and Field-Effect Transistors:** Fundamentals of BJT Operation, Minority Carrier Distributions and Terminal Currents. JFET, MESFET, MOS capacitor, MOSFET's characteristics, Threshold voltage, High Electron Mobility Transistor (HEMT).	**8**

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, Dhrubes Biswas "Semiconductor Physics and Devices", 4/e, McGraw-Hill 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: NA

Topics beyond syllabus/Advanced topics/Design: NA

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

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

Direct Assessment

Exam	**Components**	Marks	Total Marks
Internal Evaluation	A. First Quiz	10	50
	B. Mid Semester Examination	25	
	C. Assignment	10	
	D. Teacher's Assessment	5	

End Semester Examination		50	50
		Total	100

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**	**1**	**2**	**3**
CO1	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO2	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO3	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO4	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO5	3	3	1	2	3	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	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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
Electronic Devices Lab

Course code: EC24202
Course title: Electronic Devices Lab
Pre-requisite(s): Basics of Electronics
Co- requisite(s): N/A
Credits: L: 0 T: 0 P: 2 C: 1.0
Class schedule per week: 02
Class: B. Tech.
Semester / Level: III/02
Branch: ECE

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 advanced 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 Schottky diode and solar cell.
CO3	Measure the basic characteristics of MOS transistors.
CO4	Use advanced design tools to evaluate the material and electrical parameters of intrinsic and extrinsic semiconductor materials.
CO5	Use advanced design tools to construct BJT, MOS transistors and inverter and evaluate their characteristics.

Experiment No.	**Name of the Experiments**
(A) HARDWARE BASED 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 Energy-bandgap of semiconductor materials.**
3.	**Measure the I-V characteristics of an NPN transistor in Common Emitter (CE) mode.**
4.	**Measure the Id-Vd and Id-Vg characteristics of an enhancement mode n-MOSFET and a depletion mode n-MOSFET.**
5.	**Measure the I-V characteristics of a Schottky diode.**
6.	**Evaluate the I-V characteristics of an illuminated p-n junction (solar cell).**
(B) SOFTWARE BASED EXPERIMENTS	
1.	**Construct a silicon p-n junction diode and evaluate I-V characteristics curve using TCAD tool.**
2.	**Develop an enhancement mode n-MOSFET and measure Id-Vd and Id-Vg characteristics using TCAD tool.**
3.	**Construct an enhancement mode p-MOSFET and measure Id-Vd and Id-Vg characteristics using TCAD tool.**
4.	**Design a CMOS inverter and assess the DC/ Transient characteristics using TCAD tool.**
5.	**To study the n-MOSFET and plot the I-V characteristics curves using Genius simulator.**
6.	**To study the Double Gate n-MOSFET and plot the I-V characteristics curves using Genius simulator.**

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 edition, Prentice Hall, 2003.

Reference books:

1. SM Sze, Kwok K. Ng, “Physics of Semiconductor Devices”, 3/e, Wiley-Interscience, 2006.
2. Donald A. Neamen, Dhrubes 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: N/A

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	**(60)**
Attendance	**12**
Day-to-day performance	**06**
Lab Viva	**20**
Lab file	**12**
Lab Quiz-I	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II	**10**
Lab Performance Test	**30**

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	1	2	3
CO1	3	3	3	3	3	1	1	0	3	0	3	3	2	2
CO2	3	3	3	3	3	1	1	0	3	0	3	3	2	2
CO3	3	3	3	3	3	1	1	0	3	0	3	3	2	1
CO4	3	3	3	3	3	1	1	0	3	0	3	3	2	1
CO5	3	3	3	3	3	1	1	0	3	0	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, CD3, CD6, CD7, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD3, CD6, CD7, CD8
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CD4	Mini Projects/Projects	CO4	CD1, CD3, CD6, CD7, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD3, CD6, 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
Digital System Design

Course code: EC24203
Course title: Digital System Design
Pre-requisite(s): Basics Electronics
Co- requisite(s): N/A
Credits: L: 3 T: 0 P: 0 C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: III/02
Branch: ECE and allied branches

Course Objectives

This course enables the students:

1.	To understand digital logic concepts, basic operations and logic functions.
2.	To comprehend and design various combinational circuits.
3.	To understand and design various sequential circuits.
4.	To comprehend logic families, memories and timing circuits for digital applications.
5.	To know programmable logic devices and hardware description languages.

Course Outcomes

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

CO1	Comprehend digital logic concepts, basic operations and logic functions.
CO2	Implement logic gates for various combinational circuits.
CO3	Design various sequential circuits using logic gates and state diagrams.
CO4	Comprehend logic families, programmable memories and timing circuits for digital applications.
CO5	Design digital systems using programmable logic devices and hardware description languages.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction to Digital System Design, Logic gates, Boolean Algebra and De Morgan's Theorem, Sum of Product (SOP) & Product of Sum forms (POS), Canonical forms and conversions, Logic function simplification using Karnaugh maps, Logic function implementation using NAND and NOR gates, Review of number systems and codes used in digital system, Review of arithmetic used in digital system.	**8**

Module – II **Design of Combinational Circuits** Analysis and design procedure, Half and Full 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.	**8**
Module – III **Design of Sequential Circuits** Basic Latches, Flip-Flops (S-R, D, J-K, T and Master-Slave), Triggering of Flip Flops, Registers, Shift Registers, Synchronous and asynchronous counters, Design of sequential circuit using state diagrams.	**8**
Module – IV **Logic Families:** TTL, ECL, and CMOS Logic Circuits, Logic levels, voltages and currents, fan-in, fan-out, speed, power dissipation, Comparison of logic families, **Memories and Programmable Logic Design**: Types of memories, Programmable Logic Arrays (PLA), Programmable Array Logic (PAL), Concept of Programmable logic devices like FPGA.	**8**
Module – V **Timing circuits:** Astable, Monostable and Bistable multivibrators using IC-555 timer and Op-amp. **Introduction to Verilog-HDL,** Modelling Concepts, Basic Concepts, Modules and Ports, Different modelling styles in Verilog-HDL, Verilog-HDL codes for combinational and sequential circuits.	**8**

Textbooks:

1. "Digital Design", Morris Mano and Michael D. Ciletti ,4th edition PHI
2. "Modern Digital Electronics", R P. Jain and Kishor Sarawadekar, 5th Edition, McGraw Hill
3. "Verilog HDL", Samir Palnitkar, 2e, Pearson

Reference books:

1. "Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog, M. Morris Mano and Michael D. Ciletti, 6e, Pearson
2. "Fundamentals of Digital Logic with Verilog Design", Stephen Brown and Zvonko Vranesic, McGraw Hill

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

POs met through Gaps in the Syllabus: NA

Topics beyond syllabus/Advanced topics/Design: NA

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

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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	1	2	3
CO1	3	3	2	2	3	1	0	0	1	2	2	3	3	2
CO2	3	3	2	2	3	1	0	0	1	2	2	3	3	2
CO3	3	3	2	2	3	1	0	0	1	2	2	3	3	2
CO4	3	3	2	2	3	1	0	0	1	2	2	3	3	2
CO5	3	3	2	2	3	1	0	0	1	2	2	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, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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
Digital System Design Lab

Course code: EC24204
Course title: Digital System Design Lab
Pre-requisite(s): Basics Electronics
Co-requisite(s): Digital System Design
Credits: L:0 T:0 P:2 C:1.0
Class schedule per week: 02
Class: B. Tech.
Semester / Level: III/ 02
Branch: ECE and allied branches

Course Objectives
This course enables the students to:

1.	To understand digital logic concepts, basic operations and logic functions.
2.	To comprehend and design various combinational circuits.
3.	To understand and design various sequential circuits.
4.	To comprehend logic families, memories and timing circuits for digital applications.
5.	To know programmable logic devices and hardware description languages.

Course Outcomes

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

CO1	Comprehend digital logic concepts, basic operations and logic functions.
CO2	Implement logic gates for various combinational circuits.
CO3	Design various sequential circuits using logic gates.
CO4	Design memories and timing circuits for digital applications.
CO5	Design digital systems using hardware description languages.

SYLLABUS:

Experiment No.	**Name of the Experiments**
(A) HARDWARE BASED EXPERIMENTS	
1.	**Design and verify Half Adder and Full Adder circuits using logic gates.**
2.	**Design and implement Seven-Segment display unit using IC-7447.**
3.	**Implement 8:3 priority encoder using IC-74148 and 3:8 Decoder using IC-74138.**
4.	**Design and implement NAND and NOR gates using CMOS logic with IC-CD4007**

5.	**Design of S-R and J-K Flip-Flops using NAND gates.**
6.	**Construction of Astable and Monostable Multivibrators Using IC-555 Timer and plotting of output waveforms.**
(B) SOFTWARE BASED EXPERIMENTS	
1.	**Familiarization to Verilog-HDL and implementation of Half and Full adder circuits using Verilog-HDL.**
2.	**Design a 4-bit magnitude comparator circuit using Verilog-HDL.**
3.	**Design and implement 8:1 multiplexer and 1:4 demultiplexer using Verilog-HDL.**
4.	**Design and implement 4-bit counter using Verilog-HDL.**
5.	**Design ALU with functions of ADD, SUB, INVERT, OR, AND. XOR, INC, DEC, and CMP using IC-74181 with Multisim Software.**
6.	**Design a ROM (8X4 bits) using a decoder, gates, and diodes using Multisim Software.**

Books recommended:
Textbooks:

1. “Digital Design”, Morris Mano and Michael D. Ciletti ,4th edition PHI
2. “Modern Digital Electronics”, R P. Jain and Kishor Sarawadekar, 5th Edition, McGraw Hill
3. “Verilog HDL”, Samir Palnitkar, 2e, Pearson

Reference books:

1. “Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog, M. Morris Mano and Michael D. Ciletti, 6e, Pearson
2. “Fundamentals of Digital Logic with Verilog Design”, Stephen Brown and Zvonko Vranesic, McGraw 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
Progressive Evaluation	**(60)**
Attendance	**12**
Day-to-day performance	**06**
Lab Viva	**20**
Lab file	**12**
Lab Quiz-I	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II	**10**
Lab Performance Test	**30**

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**	**1**	**2**	**3**
CO1	3	3	3	2	3	1	0	1	1	1	1	3	3	2
CO2	3	3	3	2	3	1	0	1	1	1	1	3	3	2
CO3	3	3	3	2	3	1	0	1	1	1	1	3	3	2
CO4	3	3	3	2	3	1	0	1	1	1	1	3	3	2
CO5	3	3	3	2	3	1	0	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:

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD3, CD5, CD9
CD2	Tutorials/Assignments	CO2	CD1, CD3, CD5, CD9
CD3	Seminars/ Quiz (s)	CO3	CD1, CD3, CD5, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD3, CD5, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD3, 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
Network Theory

Course code: EC24205
Course title: Network Theory
Pre-requisite(s): Basics of Electrical Engineering
Co- requisite(s): N/A
Credits: L: 3 T: 0 P: 0 C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: III/02
Branch: ECE

Course Objectives

This course enables the students:

1.	List the Properties and discuss the concepts of network theory
2.	Solve problems related to network theorems
3.	Illustrate and outline the multi-terminal network in engineering
4.	Select and design of filters

Course Outcomes

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

CO1	Solve problems related to DC and AC circuits.
CO2	Apply the knowledge of basic circuital law.
CO3	Determine response of circuits consisting of dependent sources.
CO4	Evaluate transient response, Steady state response, network functions and analyze the circuits both in time and frequency domains.
CO5	Design the filters with help of electrical elements and evaluate two-port network parameters.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I **Network Topology:** Node and Mesh Analysis, Kirchoff's laws, Matrices of Graph, Properties of network matrices, Node and Mesh transformation, Source transformation and duality, Network with controlled sources, Transform networks, Linear time invariant networks, Evaluation of initial conditions, Frequency and impedance scaling.	**8**

Module – II **Network Theorems:** Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power Transfer theorem, Substitution theorem, Tellegen's theorem, Reciprocity theorem, and compensation as applied to AC circuits.	**8**
Module – III **Transient Analysis using differential equations:** D.C transient analysis: Transient response of R-L, R-C, R-L-C circuits (Series and parallel; A.C transient analysis: Transient response of R-L, R-C, R-L-C Series circuits for sinusoidal excitations, Initial conditions, Solution using differential equation.	**8**
Module – IV **Transient and Steady-State Analysis using Laplace transform:** Laplace transformation and its properties, Transient response in RL, RC and RLC circuits, Network equations and solutions using Laplace transform, Network Functions: Driving point function, transfer function, concepts of poles and zeros, Bode plot.	**8**
Module – V **Two port networks and Filters:** Two port networks, Y, Z, and h-parameters, interconnections, Introduction to filters, Low pass, High pass, Band pass, all pass and notch filter using RC Circuit.	**8**

Textbooks:

1. "Network Analysis," M E VanValkenburg, Prentice Hall India.
2. "Circuit Theory - Analysis and Synthesis," Abhijit Chakrabarti, Dhanpat Rai Publishing
3. "Circuits and Networks," M.S. Sukhija, T.K.Nagsarkar, Oxford University Press

Reference books:

1. "Electric Network Theory," Balabanian, N. and T.A. Bickart, John Wiley & Sons
2. "Network Analysis and Synthesis," Franklin Kuo, Wiley India Pvt. Limited

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 and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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**	**1**	**2**	**3**
CO1	3	3	2	0	0	0	0	0	1	1	1	3	3	2
CO2	3	3	3	2	1	0	0	0	1	1	1	3	3	2
CO3	3	3	3	3	2	2	0	0	1	1	1	3	3	2
CO4	3	3	3	3	3	3	0	0	2	2	2	3	3	2
CO5	3	3	3	2	2	3	3	3	1	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, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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
Signals and Systems

Course code: **EC24207**
Course title: **Signals and Systems**
Pre-requisite(s): Basic Electronics, Mathematics
Co-requisite(s): None
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: III/ 02
Branch: ECE

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 understand the response of LTI systems using Transform theory.
5.	To solve problems involving convolution, correlation, filtering, modulation, and sampling.

Course Outcomes

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

CO1	Understand the representation and properties of continuous-time and discrete-time signals.
CO2	Comprehend the properties of continuous-time and discrete-time systems.
CO3	Represent continuous-time and discrete-time signals with different frequency domain transformation techniques.
CO4	Analyze systems with different frequency domain transformation techniques.
CO5	Apply the concepts of signals and systems for advanced applications.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **INTRODUCTION TO SIGNALS AND SYSTEMS:** Introduction to Signal, types of signals, signal categories: periodicity, deterministic/random, energy/power, causal/non-causal, continuous/discrete. Basic signals: the unit step, the unit impulse, the sinusoid, the complex exponential. Standard operations in time. Introduction to system, System properties: linearity, shift-invariance, causality, stability.	**8**

Module – II **CONTINUOUS AND DISCRETE-TIME LTI SYSTEMS:** Impulse response, step response, convolution, correlation, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-space Representation of systems: State Space Analysis, State Transition Matrix and its Role.	
Module – III **FOURIER TRANSFORM:** Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients, Fourier Transform, DTFT, Properties of Fourier transform, magnitude and phase response. Sampling Theorem, Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects.	**8**
Module – IV **LAPLACE TRANSFORMS:** Laplace Transform for continuous-time signals and systems, Transfer/system functions, properties of Laplace transform, poles and zeros of system functions and signals, Laplace domain analysis, the solution to differential equations and system behavior.	**8**
Module – V **Z-TRANSFORM:** Z-transform, Region of convergence and its properties, Inverse Z-transform, properties of ZT, the discrete Fourier transform (DFT), Parseval's Theorem, Systems Characterized by Linear Constant Coefficient Difference Equation, The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.	**8**

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): NA

POs met through Gaps in the Syllabus: NA

Topics beyond syllabus/Advanced topics/Design: NA

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

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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**	**1**	**2**	**3**
CO1	3	3	3	3	3	2	1	2	2	2	3	3	3	3
CO2	3	3	3	3	3	2	1	2	2	2	3	3	3	3
CO3	3	3	3	3	3	2	1	2	2	2	3	3	3	3
CO4	3	3	3	3	3	2	1	2	2	2	3	3	3	3
CO5	3	3	3	3	3	2	1	2	2	2	3	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, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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
Probability and Random Processes

Course code: EC24209
Course title: Probability and Random Processes
Pre-requisite(s): Mathematics
Co- requisite(s): N/A
Credits: L: 3 T: 0 P: 0 C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: III/02
Branch: ECE

Course Objectives (to be updated)

This course enables the students:

1.	To develop ability to explain the concept of probability, its properties and to evaluate the probability of different events.
2.	To develop ability to explain the concept of random variables, inequalities and random processes.
3.	To characterize the features of random variables, inequalities and random processes.
4.	To examine the features of random variables, inequalities and random processes
5.	To evaluate the features of random variables, inequalities and random processes

Course Outcomes (to be updated)

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

CO1	Explain the concept of probability, its properties and to evaluate the probability of different events
CO2	Explain the concept of random variables, inequalities and random processes.
CO3	Characterize the features of random variables, inequalities and random processes
CO4	Examine the features of random variables, inequalities and random processes
CO5	Evaluate the features of random variables, inequalities and random processes

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Randomness, uncertainty and its description:** Random experiments/phenomenon, Outcomes of the random experiment, Sample space, Trials, Events, Definitions of probability: Axiomatic, Relative frequency and Classical, Probability of an event, Concepts of set theory and probability theory to explain Random experiments, Mutually exclusive events, Probability space; Conditional probability, Independence of two and three events, Total probability and Bayes' theorem.	**8**

Module – II **One random variable and its characterization:** The concept of random variable, Continuous and discrete random variables, Cumulative distribution function (CDF) and Probability density function (PDF), and their properties, Probability mass function (p.m.f), Specific continuous type random variables: Normal (Gaussian), Uniform, Exponential, Gamma, Chi-square, Rayleigh, and Rician distribution; Specific discrete type random variables: Bernoulli, Binomial, Poisson, Geometric and Negative binomial, Conditional distribution, Functions of one random variable, Expectation, Mean, Conditional mean, Variance, Moments, Characteristic Functions, Moment generating functions and Moment theorem.	**9**
Module – III **Two Random Variables and their characterization:** Joint distribution and Joint density functions, and their properties, Marginal statistics, Joint Normality, One and two functions of two random variables, joint moments, Covariance, Correlation coefficient, Uncorrelatedness, Orthogonality, Moments, Joint characteristic functions, Joint moment generating function, Moment theorem, Conditional distributions, Conditional expected values.	**9**
Module – IV **Inequalities, Stochastic Convergences, and Limit Theorems:** Markov inequality, Chebyshev inequality and Chernoff bounds, modes of convergence (everywhere, almost everywhere, probability, distribution and mean square), The law of large numbers, Central limit theorem,	**6**
Module – V **Random Processes and Linear Systems:** Random Data/Signals, Stationarity and Ergodicity, 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, Applications of probability and random processes to few important engineering domains.	**8**

Textbooks:

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 books:

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 and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Teacher's Assessment	15
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	1	2	3
CO1	3	3	2	2	3	2	1	2	1	2	3	3	3	3
CO2	3	3	2	3	3	2	1	2	1	3	3	3	3	3
CO3	3	3	2	3	3	2	1	2	1	3	3	3	3	3
CO4	3	3	2	3	3	2	1	2	1	3	3	3	3	3
CO5	3	3	2	3	3	2	1	2	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 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
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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
Analog Circuits

Course code: EC24251
Course title: Analog Circuits
Pre-requisite(s): Basics of Electrical Engineering, Basics Electronics
Co- requisite(s): N/A
Credits: L: 3 T: 1 P: 0 C:4
Class schedule per week: 04
Class: B. Tech.
Semester / Level: IV/02
Branch: ECE

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 understand ADC and DAC.

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, oscillator, filter circuits.
CO5	Designing ADC and DAC.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I RC circuits and its response to step, pulse, and square wave inputs, diode clipping and clamping circuits. Overview of small signal model (hybrid-π model) of BJT for CE, CB, and CC, configurations; Estimation of voltage gain, input and output resistance for CE configuration; CE amplifier with emitter resistance; Frequency response of CE amplifier: High and Low Frequency Response of CE amplifier, Estimation of gain and bandwidth; Miller's Theorem.	**10**

Module – II Overview of small signal model (hybrid-π model) of MOS for CS, CG, and CD, configurations; Estimation of voltage gain, input and output resistance for CS configuration; Frequency response of CS amplifier: High and Low Frequency Response of CS amplifier, Estimation of gain and bandwidth. High and low frequency analysis of RC coupled amplifiers, Cascode amplifier. Various classes of operation (Class A, B, AB, C etc.), their power efficiency and linearity issues.	**9**
Module – III Feedback Amplifiers: 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, effect of feedback on gain, bandwidth etc., Concept of stability, gain margin and phase margin. Oscillators: Barkhausen criterion, RC oscillators (phase shift, Wien bridge etc.), LC oscillators (Hartley, Colpitt, Clapp etc.)	**10**
Module – IV MOS Current mirror, MOS-differential amplifier, transfer characteristics of differential amplifier, calculation of differential gain, common mode gain, CMRR. MOS-operational amplifier and different stages, inverting and non-inverting amplifier, zero-crossing detector, precision rectifier, peak detector, logarithmic amplifier, Schmitt trigger. Active filters: Low-pass, high-pass, band-pass and band-stop.	**10**
Module – V Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistor string etc. Analog-to-digital converters (ADC): Single slope, dual slope, successive approximation, flash etc. Switched capacitor circuits: Basic concept, practical configurations, application in amplifier, integrator, ADC etc.	**9**

Textbooks:

1. "Microelectronic Circuits," Adel Sedra and Kenneth Smith, Oxford University Press
2. "Fundamentals of Microelectronics," Behzad Razavi, John Wiley and Sons Ltd
3. "Operational Amplifiers and Linear Integrated Circuits," Ramakant A. Gayakwad, Pearson Education India
4. "Design of Analog CMOS Integrated Circuits" Behzad Razavi, McGraw Hill Education India

Reference books:

1. "Electronic Devices and Circuit", Millman, Halkias, S Jit, McGraw Hill Education India
2. "Integrated Electronics", Millman & Halkias, McGraw Hill Education India

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 and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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	1	2	3
CO1	3	3	2	3	3	1	0	0	3	0	3	3	3	3
CO2	3	3	2	3	3	2	0	0	3	0	3	3	3	3
CO3	3	3	2	3	3	2	0	0	3	0	3	3	3	3
CO4	3	3	2	3	3	3	0	0	3	0	3	3	3	3
CO5	3	3	2	3	3	3	0	0	3	0	3	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, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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
Analog Circuits Lab

Course code: EC24252
Course title: Analog Circuits Lab
Pre-requisite(s): Basics Electronics,
Co- requisite(s): Analog Circuits
Credits: L:0 T:0 P:2 C:1.0
Class schedule per week: 02
Class: B. Tech.
Semester / Level: IV/ 02
Branch: ECE

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	Design and analyze the feedback amplifier circuits.
CO3	Design and characterize the differential amplifier and oscillator.
CO4	Design and characterize the active band pass, band stop filter circuits.
CO5	Design the analog-to-digital and digital-to-analog converter circuits.

Experiment No.	**Name of the Experiments**
(A) HARDWARE BASED EXPERIMENTS	
1.	**Design of a low pass and high pass RC circuits for a given cutoff frequency and obtain its frequency response.**
2.	**Find the frequency response of single stage amplifier and determine the mid-band gain and bandwidth of the amplifier.**
3.	**Design and obtain the frequency response characteristics of Darlington pair amplifier.**

4.	**Design voltage-shunt feedback amplifier and find the frequency response of both amplifiers with and without feedback.**
5.	**Design of RC phase shift oscillator with a given frequency of oscillation and plotting of output waveform.**
6.	**Construction of R-2R Ladder type 4-bit D/A converter.**
(B) SOFTWARE BASED EXPERIMENTS	
1.	**Find the frequency response two stage RC coupled amplifier.**
2.	**Design a BJT based tuned amplifier and find its frequency response.**
3.	**Design of basic Current Mirror circuit using MOSFET.**
4.	**Design of a differential amplifier using MOSFET and determine the differential mode gain, common mode gain, and CMRR.**
5.	**Design and determine the characteristics of Active filters: band pass, band stop.**
6.	**Construction of 4-bit comparator type A/D Converter.**

Books recommended:

Textbooks:

1. "Microelectronics Circuits," Adel S. Sedra, Kenneth C. Smith, Oxford. University Press

Reference books:

1. "Integrated Electronics: Analog and Digital Circuits and Systems," Jacob Millman and Christos Halkias, McGraw Hill
2. "Electronic Devices and Circuit Theory," Robert L. Boylestad, Louis Nashelsky, Pearson Education

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
Progressive Evaluation	**(60)**
Attendance	**12**
Day-to-day performance	**06**
Lab Viva	**20**
Lab file	**12**
Lab Quiz-I	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II	**10**
Lab Performance Test	**30**

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**	**1**	**2**	**3**
CO1	3	3	2	2	3	1	0	0	3	0	3	3	3	3
CO2	3	3	2	2	3	2	0	0	3	0	3	3	3	3
CO3	3	3	2	2	3	2	0	0	3	0	3	3	3	3
CO4	3	3	2	2	3	3	0	0	3	0	3	3	3	3
CO5	3	3	2	2	3	3	0	0	3	0	3	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, CD3, CD5, CD9
CD2	Tutorials/Assignments	CO2	CD1, CD3, CD5, CD9
CD3	Seminars/ Quiz (s)	CO3	CD1, CD3, CD5, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD3, CD5, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD3, 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
Analog Communication

Course code: EC24253
Course title: Analog Communication
Pre-requisite(s): Basic Electronics, Signals and Systems
Co- requisite(s): N/A
Credits: L: 3 T: 1 P: 0 C:4
Class schedule per week: 03
Class: B. Tech.
Semester / Level: IV/02
Branch: ECE

Course Objectives

This course enables the students:

1.	To develop ability to explain the concept of time domain and frequency domain characteristics of signals and various performance parameters of analog communication.
2.	To describe the various continuous wave modulation techniques.
3.	To develop the ability to evaluate the performance of various continuous wave modulation schemes.
4.	To describe and evaluate and the performance of various pulse modulation techniques.
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	Explain the concept of time domain and frequency domain characteristics of signals and various performance parameters of analog communication.
CO2	Describe the various continuous wave modulation techniques
CO3	Evaluate the performance of various continuous wave modulation schemes.
CO4	Describe, and evaluate and the performance of various pulse modulation techniques.
CO5	Evaluate the performance of analog communication system in the presence of noise.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I **Signal analysis:** Time domain and frequency domain representation of a signal, Review of Fourier transform and its properties, energy and power spectral density, distortion less transmission, Hilbert transform, pre-envelope and canonical representation of band pass signals.	**8**

Module – II **Amplitude modulation- demodulation communication systems:** 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 (FDM).	**8**
Module – III **Angle modulation - demodulation communication systems:** 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 AM and FM receiver, and their characteristics.	**8**
Module – IV **Pulse modulation demodulation communication systems:** Sampling process of lowpass and bandpass signal, Types of sampling, pulse amplitude modulation, pulse duration modulation, pulse position modulation, time division multiplexing (TDM).	**8**
Module – V **Noise in communication systems:** 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.	**8**

Textbooks:

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 and Evaluation Procedure:PO2

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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	1	2	3
CO1	3	3	3	3	2	2	1	2	1	2	3	3	3	3
CO2	3	3	3	3	2	2	1	2	1	2	3	3	3	3
CO3	3	3	3	3	2	2	1	2	1	2	3	3	3	3
CO4	3	3	3	3	2	2	1	2	1	2	3	3	3	3
CO5	3	3	3	3	2	2	2	2	1	2	3	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, 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

Computer Architecture

Course code: EC24255
Course title: Computer Architecture
Pre-requisite(s): Digital System Design
Co- requisite(s): N/A
Credits: L: 3 T: 0 P: 0 C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: IV/02
Branch: ECE

Course Objectives

This course enables the students:

1.	To impart basic concepts of computer architecture and organization,
2.	To explain key skills of constructing cost-effective computer systems.
3.	To familiarize the basic CPU organization.
4.	To help students in understanding various memory devices.
5.	To facilitate students in learning IO communication.

Course Outcomes

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

CO1	Identify various components of computer and their interconnection.
CO2	Identify basic components and design of the CPU: the ALU and control unit.
CO3	Compare and select various Memory devices as per requirement.
CO4	Compare various types of IO mapping techniques
CO5	Critique the performance issues of cache memory and virtual memory.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I **STRUCTURE OF COMPUTERS:** Revision of logic circuits with emphasis on control lines, SAP concepts with stress on timing diagrams, Microinstructions, Microprogramming, Variable machine cycle, Computer types, Functional units, Basic operational concepts, Von Neumann Architecture, Bus Structures, Software, Performance, Multiprocessors and Multicomputer.	**8**

Module – II **BASIC COMPUTER ORGANIZATION AND DESIGN**: Instruction codes, Computer Registers, Computer Instructions and Instruction cycle. Timing and Control, Memory-Reference Instructions, Input-Output and interrupt. Central processing unit: Stack organization, Instruction Formats, Addressing Modes, Data Transfer and Manipulation, Complex Instruction Set Computer (CISC) Reduced Instruction Set Computer (RISC), CISC vs RISC.	**8**
Module – III **REGISTER TRANSFER AND MICRO-OPERATIONS:** Register Transfer Language, Register Transfer, Bus and Memory Transfers, Arithmetic Micro-Operations, Logic Micro-Operations, Shift Micro-Operations, Arithmetic logic shift unit. **MICRO-PROGRAMMED CONTROL:** Control Memory, Address Sequencing, Micro-Program example, Design of Control Unit.	**8**
Module – IV **MEMORY SYSTEM:** Memory Hierarchy, Semiconductor Memories, RAM (Random Access Memory), Read Only Memory (ROM), Types of ROM, Cache Memory, Performance considerations, Virtual memory, Paging, Secondary Storage, RAID.	**8**
Module – V **INPUT-OUTPUT:** I/O interface, Programmed IO, Memory Mapped IO, Interrupt Driven IO, DMA. MULTIPROCESSORS: Characteristics of multiprocessors, Interconnection structures, Inter Processor Arbitration, Inter processor Communication and Synchronization, Cache Coherence.	**8**

Textbooks:

1. Digital Computer Electronics, 2/e. by A. P. Malvino.
2. Computer System Architecture, M. Moris Mano (2006), 3rd edition, Pearson/PHI, India.

Reference books:

1. Computer Organization and Architecture- designing for performance, William Stallings (2010), 8th edition, Prentice Hall, New Jersy.
2. Structured Computer Organization, Anrew S. Tanenbaum (2006), 5th edition, Pearson Education Inc.

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

POs met through Gaps in the Syllabus: NA

Topics beyond syllabus/Advanced topics/Design: NA

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

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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	1	2	3
CO1	3	3	2	2	2	1	0	0	1	2	2	3	3	2
CO2	3	3	2	2	2	1	0	0	1	2	2	3	3	2
CO3	3	3	2	2	2	1	0	0	1	2	2	3	3	2
CO4	3	3	2	2	2	1	0	0	1	2	2	3	3	2
CO5	3	3	2	2	2	1	0	0	1	2	2	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, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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

VLSI Design

Course code: EC24257
Course Title: VLSI Design
Pre-requisite(s): Basic Electronics, Electronic Devices
Co-requisite(s): NA
Credits: L: 3 T: 1 P: 0 C: 4
Class schedule per week: 04
Class: B. Tech.
Semester / Level: IV/02
Branch: ECE

Course Objectives

This course enables the students to:

1.	Understand the static and dynamic behavior of MOSFET and CMOS inverter.
2.	Interpret the characteristics of combinational circuits in CMOS.
3.	Appraise and analyse the characteristics of sequential logic circuits in CMOS.
4.	Design semiconductor memory circuits.
5.	Create layout of CMOS circuits and design I/O pads.

Course Outcomes

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

CO1	Describe short-channel MOSFETs, combinational, sequential, and memory circuits.
CO2	Classify the combinational, sequential, and memory circuits.
CO3	Sketch the combinational, sequential, and memory circuits.
CO4	Design various combinational, sequential, and memory circuits.
CO5	Solve day-to-day life problems using electronic circuits

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Static and dynamic behavior of MOSFET and CMOS inverter:** MOS capacitances, Long-channel MOSFET's current model, Threshold voltage, Region of operations, V-I characteristics, Short-channel effects, Subthreshold Conduction, Source-Drain Resistance; Static and Dynamic Behaviour of CMOS Inverter: Switching Threshold, Noise Margin formulation, Computing the Capacitances, Propagation Delay, Power, PDP, EDP.	**12**

Module – II **CMOS Combinational Circuits:** Static CMOS Design: Pseudo-NMOS, Pass-Transistor, Complementary pass-transistor, Transmission gate, Complementary-CMOS. Dynamic CMOS Design: Dynamic, Domino, C^{2}MOS, Methods to reduce delays, Switching Activity, Design techniques to reduce switching activity and power consumption.	**6**
Module – III **CMOS Sequential Circuits:** Static Latches and Registers, Dynamic Latches and Registers, Synchronous and Asynchronous design methodology, Sources of Skew and Jitter, Static Timing Analysis (STA): Min and Max Timing Paths, Combinational Path Delay, Input to Flip-flop Path, Flip-flop to Flip-flop Path, Multiple Paths, Slack Calculation.	**6**
Module – IV **Semiconductor Memories:** Classification of semiconductor memory, Memory decoding and peripheral circuits, Design of 6T SRAM cell, its read/write operation and its layout, 3T and 1T DRAM cell, OR/NOR/NAND-ROM, Flash Memory.	**8**
Module – V **Interconnect, I/O pads, and Layout:** Layouts of universal gates and design rules, Interconnect Parameters, Electrical Wire Models, Capacitive, Resistive, and Inductive Parasitics, wire models, I/O pads, ESD protection circuit, bidirectional and Schmitt trigger in the Input pad.	**8**

Textbooks:

1. Jan M. Rabaey, A. Chandrakasan, B. Nikolic, "Digital Integrated Circuits: A Design Perspective", 2nd ed., Prentice Hall, 2003.
2. Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design", 3rd ed. McGraw Hill, 2003.
3. Neil H. E. Weste, David Money Harris, "CMOS VLSI Design – A Circuits and Systems Perspective," 4th ed., Addison Wesley, 2011.

Reference books:

1. Neil H. E. Weste, David Money Harris, "CMOS VLSI Design – A Circuits and Systems Perspective," 3rd ed., Pearson Education, 2006.

Gaps in the syllabus (to meet Industry/Profession requirements): Hands-on-practical for CMOS IC (Integrated Circuit) fabrication.

POs met through Gaps in the Syllabus: 10

Topics beyond syllabus/Advanced topics/Design: NA

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

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

Exam	**Components**	Marks	Total Marks
Internal Evaluation	A. First Quiz	10	50
	B. Mid Semester Examination	25	
	C. Assignment	10	
	D. Teacher's Assessment	5	
End Semester Examination		50	50
		Total	100

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**	**1**	**2**	**3**
CO1	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO2	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO3	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO4	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO5	3	3	1	2	3	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	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD4, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD4, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD4, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2, CD3, CD4, 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
VLSI Design Lab

Course code: EC24258
Course Title: VLSI Design Lab
Pre-requisite(s): Basic Electronics, Electronic Devices
Co-requisite(s): VLSI Design
Credits: L: 0 T: 0 P: 2 C: 1
Class period per week: 01
Class: B. Tech.
Semester / Level: IV/02
Branch: ECE

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 SCEs.
4.	Integrate basic blocks to build a bigger module and evaluate the results.
5.	Design digital, memory and analog subsystems keeping design goals in consideration.

Course Outcomes

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

CO1	Translate their theoretical knowledge while modeling the basic combinational circuits using HDL and explain the simulation results.
CO2	Apply appropriate bias to the terminals of an PMOSFET/PMOSFET and observe short-channel effects.
CO3	Design sequential circuits (Moore/Mealy machines) and analyse the results.
CO4	Design and characterize memory circuit (6T SRAM cell).
CO5	Design digital, analog and memory circuits for solving day-to-day life problems.

SYLLABUS*

Experiment No.	**Name of the Experiments**
1.	**Write Verilog/SystemVerilog RTL code to design an adder circuit that adds three 8-bit binary numbers using Xilinx development software.**
2.	**Write Verilog/SystemVerilog RTL code to design a Moore machine using Xilinx development software with given state transition diagram.**
3.	**Write Verilog/SystemVerilog RTL code to design a Mealy machine using**

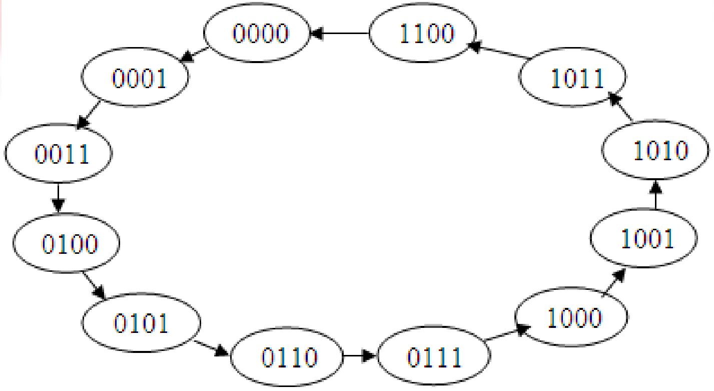
	Xilinx development software with given state transition diagram.
4.	**Design a 1-bit full adder cell at MOSFET-level and estimate the propagation delay of the sum and carry outputs of the design using HSPICE of Synopsys/ Virtuoso ADE of Cadence.**
5.	**Draw the optimized layout of a 4-input NAND gate to improve its performance Microwind/ Virtuoso ADE of Cadence.**
6.	**Draw the optimized layout of a 4-input domino AND gate to improve its performance Microwind/ Virtuoso ADE of Cadence.**
7.	**Study short-channel effects in a properly biased nMOSFET using HSPICE of Synopsys/ Virtuoso ADE of Cadence.**
8.	**Design a 2-input NAND gate using Static CMOS and pseudo-NMOS logic families with given specifications and design a 2-input XOR using symbols of 2-input SCMOS NAND gate using HSPICE of Synopsys/ Virtuoso ADE of Cadence.**
9.	**Design a bidirectional Pad circuitry using HSPICE of Synopsys/ Virtuoso ADE of Cadence.**
10.	**Design an S-R flipflop at MOSFET-level and convert it into D-flipflop using HSPICE of Synopsys/ Virtuoso ADE of Cadence.**
11.	**Design a 6T SRAM cell and draw its layout using HSPICE of Synopsys/ Virtuoso ADE of Cadence/ Microwind.**
12.	**Design an Op-amp based square wave generator with a frequency of at least 1 MHz using HSPICE of Synopsys/ Virtuoso ADE of Cadence.**

* Lab is the application of the theory (i.e., hands-on experiments related to the course contents). Therefore, **EC24257 VLSI Design** is the syllabus for the **EC24258 VLSI Design Lab**. Following experiments are the guidelines for the students. However, the questions for exams are not limited to this experiment list.

List of optional experiments:

1. 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.
2. 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.

3. Write a 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.
4. Write a Verilog/SystemVerilog model and develop a Fibonacci LFSR with characteristic polynomial of 1 + x + x4. Simulate it with the seed test pattern = 1000 and prepare a table with the results. Interpret the same for its correctness.
5. Write a 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.
6. 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.
7. 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.
8. Write a 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.
9. Develop a 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.
10. Write a 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.
11. Outline a model of 4-bit ripple carry full adder and translate/express the same into 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.
12. Outline a 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 analyze the results.



13. Design of Universal Shift Register-Behavioural Model (HDL Example 6.1 (Morris Mano, Michael D. Ciletti, 5/e))

14. Design of Universal Shift Register-Structural Model (HDL Example 6.2 (Morris Mano, Michael D. Ciletti, 5/e))
15. Design of Synchronous Counter (HDL Example 6.3 (Morris Mano, Michael D. Ciletti, 5/e))
16. Design of Ripple Counter (HDL Example 6.4 (Morris Mano, Michael D. Ciletti, 5/e))
17. Design of Sequential Multiplier (HDL Example 8.5 (Morris Mano, Michael D. Ciletti, 5/e))
18. Design of Test bench for the binary multiplier (HDL Example 8.6 (Morris Mano, Michael D. Ciletti, 5/e))
19. Behavioural (RTL) description of a parallel multiplier (n = 8) (HDL Example 8.7 (Morris Mano, Michael D. Ciletti, 5/e))

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," 4th ed., Addison Wesley, 2011.
3. Neil H. E. Weste, David Money Harris, "CMOS VLSI Design – A Circuits and Systems Perspective," 3rd ed., Pearson Education, 2006.

Reference books:

1. Behzad Razavi, "Fundamentals of Microelectronics," Wiley, 2009.
2. Samir Palnitkar, "Verilog HDL: A guide to Digital Design and Synthesis," SunSoft Press, 1996.
3. Stuart Sutherland, Simon Davidmann, Peter Flake, "SystemVerilog Design - A Guide to Using SystemVerilog for Hardware Design and Modeling," 2nd ed., Springer, 2006.
4. Morris Mano, Michael D. Ciletti, "Digital Design: With an Introduction to the Verilog HDL", 5th Edition, Prentice Hall, 2013.

Gaps in the syllabus (to meet Industry/Profession requirements): Hands-on-practical for CMOS IC (Integrated Circuit) fabrication.

POs met through Gaps in the Syllabus: 10.

Topics beyond syllabus/Advanced topics/Design: NA

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

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

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	**(60)**
Attendance Marks	**12**
Day-to-day performance Marks	**06**
Lab Viva marks	**20**
Lab file Marks	**12**
Lab Quiz-I Marks	**10**

End SEM Evaluation	**(40)**
Lab Quiz-II Marks	**10**
Lab performance Marks	**30**

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**	**1**	**2**	**3**
CO1	3	3	1	2	3	1	1	2	2	2	2	2	2	1
CO2	3	3	1	2	3	1	1	2	2	2	2	2	2	1
CO3	3	2	1	2	3	1	1	2	2	2	2	2	2	1
CO4	3	3	1	2	3	1	1	2	2	2	2	2	2	1
CO5	3	2	1	2	3	1	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, CD3, CD5, CD8, CD9
CD2	Tutorials/Assignments	CO2	CD1, CD3, CD5, CD8, CD9
CD3	Seminars/ Quiz (s)	CO3	CD1, CD3, CD5, CD8, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD3, CD5, CD8, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD3, CD5, CD8, CD9
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as the use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET
Electromagnetic Fields and Waves

Course code: EC24301
Course title: Electromagnetic Fields and Waves
Pre-requisite(s): Physics, Mathematics, Network Theory
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

Course Objectives

This course enables the students:

1.	To apply the basic knowledge of mathematics, physics and science for design and development of various engineering problems involving electromagnetic fields.
2.	To understand the concept of Maxwell's equations to analyse time varying potentials and electromagnetic wave equations.
3.	To understand the concept of electromagnetic wave propagation in guided and unguided medium having different medium properties and different boundary conditions.
4.	To lay the foundations of electromagnetic engineering and its applications in modern communications involving both wireless and guided wave medium.
5.	To develop the basic concept of antennas and their properties.

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	Comprehend Maxwell's equation in differential and integral forms.
CO3	Analyse the phenomena of wave propagation in different media and its interfaces.
CO4	Analyse different parameters of electromagnetic wave propagation through transmission lines, waveguides and antennas.
CO5	Apply electromagnetic concepts in diverse engineering problems.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Review of electrostatics and electromagnetics **Maxwell's Equations**: Faraday's Law, Transformer & Motional EMF, Displacement Current, Maxwell's Equations (Generalized form). Electromagnetic Boundary Conditions and Wave Equation, Time varying Potentials and Fields, Time harmonic fields,Time harmonics Maxwell's Equations.	**12**
Module – II **EM Wave propagation:** Plane Waves in unbounded homogeneous media, plane waves in free space and lossy media, skin depth, Electromagnetic power flow and Poynting vector, Polarization of Electromagnetic waves, Reflection on conducting & dielectric boundaries at normal and oblique (for parallel and perpendicular polarization) incidence, Brewster's Angle.	**8**
Module – III **Transmission lines:** Transmission line parameters and equations, The Smith Chart, Impedance Matching - Quarter Wave Transformer and Single Stub Matching, Impedance Measurement, slotted line, planar transmission: microstrip lines, slot lines, slot lines and co-planar lines.	**8**
Module – IV **Waveguides:** Parallel Plate Waveguides, TE and TM modes in Rectangular Waveguide, Rectangular Cavity Resonator, Quality factor of the rectangular Cavity Resonator.	**6**
Module – V **Antennas:** Antenna basics and parameters, Hertzian Dipole, Monopoles and Dipoles.	**6**

Textbooks:

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

1. Application of EM fields and Waves in the analysis of EM interference
2. 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
Assignment	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**	**1**	**2**	**3**
CO1	3	3	1	2	2	0	0	2	1	0	2	3	2	2
CO2	3	3	2	3	2	0	0	1	0	0	3	2	2	2
CO3	3	2	2	1	2	1	0	2	2	1	2	3	2	3
CO4	3	2	2	2	2	1	1	2	2	1	2	3	2	2
CO5	3	3	3	3	2	1	2	3	2	1	2	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, 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

Digital Communication

Course Code: EC24303
Course Title: Digital Communication
Pre-requisite(s): 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: V/03
Branch: ECE

Course Objectives

This course envisions to impart to students to:

1.	To know the principles of sampling, Quantization and various waveform coding schemes.
2.	To learn the various baseband transmission schemes
3.	To learn the different digital modulation techniques
4.	To know the elements of information theory
5.	To know spread spectrum techniques

Course Outcomes

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

CO1	Convert analog signal to digital signal and its application in the communication system.
CO2	Design, develop and apply the concepts of various modulation techniques
CO3	Analyze the performance of different digital communication systems.
CO4	Apply the techniques to reduce the probability of error and improve the security and efficiency.
CO5	Apply digital communication in the military and commercial applications.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction to digital communication System, Analog to digital conversion: 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.	**10**

Module – II Geometric Representation of Signals, The Gram-Schmidt Orthogonalization Procedure, Optimum Filter, Matched Filter, Error Rate due to Noise, Correlation Receiver, Intersymbol Interference, Nyquist Criterion for Distortion-less Baseband Binary Transmission.	**8**
Module – III 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.	**8**
Module – IV 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.	**7**
Module – V 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.	**7**

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
Assignment/ 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**	**1**	**2**	**3**
CO1	3	3	2	2	3	2	1	3	1	2	3	3	3	3
CO2	3	3	3	3	3	2	1	3	1	3	3	3	3	3
CO3	3	3	3	3	3	3	2	3	1	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	1	3	3	3	3	3
CO5	3	3	3	3	3	3	2	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 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	CO1, CO2, CO3, CO4, CO5	
CD9	Simulation	CO1, CO2, CO3, CO4, CO5	

COURSE INFORMATION SHEET

Communication System Lab

Course code: EC24304
Course title: Communication System Lab
Pre-requisite(s): Analog Communication
Co- requisite(s): Digital Communication
Credits: L: 0 T: 0 P: 2 C:1
Class schedule per week: 02
Class: B. Tech.
Semester / Level: V/03
Branch: ECE

Course Objectives

This course enables the students: (to be updated)

1.	To develop an understanding about the analog modulation/demodulation techniques
2.	To evaluate the various features of the analog modulation/demodulation techniques
3.	To develop an understanding about the digital modulation/demodulation techniques
4.	To evaluate the various features of the digital modulation/demodulation techniques
5.	To explain and characterize the features of various waveform coding techniques.

Course Outcomes (to be updated)

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

CO1	Demonstrate the understanding about the analog modulation/demodulation techniques
CO2	Evaluate the various features of the analog modulation/demodulation techniques.
CO3	Demonstrate the understanding about the digital modulation/demodulation techniques
CO4	Evaluate the various features of the digital modulation/demodulation techniques
CO5	Explain and characterize the features of various waveform coding techniques

List of Experiments

Exp. No.	**Name of the Experiments**
	(A) HARDWARE BASED EXPERIMENTS
1.	Generation and detection of amplitude modulated (AM) wave and calculation of percentage modulation.
2.	Investigation of signal sampling and reconstruction.
3.	Generation and detection of PAM, PWM, and PPM.
4.	Investigation of TDM transmitter and receiver system.

5.	Investigation of practical PCM, DM and ADM systems.
6.	Investigation of ASK, FSK, PSK modulation/demodulation.
(B) SOFTWARE BASED EXPERIMENTS	
1.	Design of DSB-SC and SCB-SC modulation and demodulation systems using ALTAIR Solid Thinking Embed/Comm.
2.	Design of frequency modulation and demodulation systems using ALTAIR Solid Thinking Embed/Comm.
3.	Design of A-law and μ-law companding in PCM using ALTAIR Solid Thinking Embed/Comm.
4.	Design of QPSK modulator/demodulator using ALTAIR Solid Thinking Embed/Comm.
5.	Design of QAM modulator/demodulator using ALTAIR Solid Thinking Embed/Comm.
6.	Design of MSK modulator/demodulator using ALTAIR Solid Thinking Embed/Comm.

List of Optional Experiments

Experiment No.	**Name of the Experiments**
(A) HARDWARE BASED EXPERIMENTS	
1.	Design and implementation of 2nd and 4th order Low pass Butterworth filters.
2.	Investigation of QPSK modulation and demodulation using ST 2112 QAM trainer kit.
3.	Investigation of QAM modulation and demodulation using ST 2112 QAM trainer kit.
4.	Investigation of MSK modulation/demodulation using trainer kits.
(B) SOFTWARE BASED EXPERIMENTS	
1.	Investigation of Signal Sampling and Reconstruction using ALTAIR Solid Thinking Embed/Comm.
2.	Design of Frequency Modulation and Demodulation Systems using ALTAIR Solid Thinking Embed/Comm.
3.	Design and implementation of 2nd and 4th order Low pass Butterworth filters using Multisim.
4.	Design of PAM, PWM, PPM Modulation and Demodulation Systems using ALTAIR Solid Thinking Embed/Comm.
5.	Design of ASK, PSK, FSK modulator/demodulator using ALTAIR Solid Thinking Embed/Comm.

Text books:

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 Book:

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
Progressive Evaluation	**(60)**
Attendance Marks	**12**
Day-to-day performance Marks	**06**
Lab Viva marks	**20**
Lab file Marks	**12**
Lab Quiz-I Marks	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II Marks	**10**
Lab performance Marks	**30**

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**	**1**	**2**	**3**
CO1	3	2	3	2	3	2	1	3	2	2	3	3	3	3
CO2	3	3	3	3	3	2	1	3	2	2	3	3	3	3
CO3	3	3	3	2	3	2	1	3	2	2	3	3	3	3
CO4	3	3	3	3	3	2	1	3	2	2	3	3	3	3
CO5	3	3	3	3	3	2	1	3	2	2	3	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, 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

Microprocessors

Course Code: EC24305
Course Title: Microprocessors
Pre-requisite(s): Digital System Design, Computer Architecture
Co- requisite(s):
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: V/03
Branch: ECE

Course Objectives

This course envisions to impart students to:

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

Course Outcomes

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

CO1	Define the architectural differences between Intel 8085,8086 and ARM processors.
CO2	Apply the assembly language programming concepts for the design of efficient codes for given problem.
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 Microprocessors.
CO5	Develop Microprocessor based products to meet the industrial requirements.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module – I Architecture of 8085 Processor, Functions of all signals, Bus concepts, Multiplexed and De-multiplexed Bus. Instruction set, Addressing modes, Timing diagrams. FEO. 8085 Programming examples on Time delay, Looping, Sorting and Code conversions.	**8**

Module – II Memory Interfacing, Memory Mapped I/O, I/O Mapped I/O, Hardware and Software Interrupts, Interrupt instructions, Programmed I/O, Interrupt driven I/O and DMA. Introduction to 16-bit processor, 8086 architectures, BIU and EU, pipelining.	**8**
Module – III 8086 Pin description, Maximum and Minimum Mode, Memory organization, Advantages of memory segmentation, Memory banking (even and odd), Instruction set, Addressing modes. Programming Examples.	**8**
Module – IV Introduction of programmable peripheral interfacing (PPI), Architecture of 8255, Modes of operation, ADC 0801/0808, and its interfacing with 8085/86, DAC 0808 and its interfacing with 8085/86, Sample and Hold. 8253(PIT), Modes of operation, Programming examples. DAS architecture and its programming in automation applications.	**8**
Module – V RISC Vs CISC Architecture, ARM Processor Architecture, ARM Core data flow model, Barrel Shifter, ARM processor modes and families.	**8**

Textbooks:

1. “Microprocessor Architecture, Programming and Applications with 8085” by R. S. Gaonkar, PRI Publication
2. “Advanced Microprocessor and Peripherals” By A.K. Ray, K.M. Bhurchandi, TMH
3. “ARM System-on-Chip Architecture” By Steve Furber, Pearson Education
4. ARM architecture reference manual, 2/e by David Seal.

Reference Books:

1. Intel Manual’s for 8085, 8086, 8051 and other peripheral chips.
2. Microprocessor and Interfacing, Programming of Hardware” by Douglas Hall. Pearson Education
3. Advanced Microprocessor” by Y. Rajasree. New Age Publishers

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

POs met through Gaps in the Syllabus: NA

Topics beyond syllabus/Advanced topics/Design: NA

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

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

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

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes into Program Outcomes:

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

Microprocessors Lab

Course code: EC24306
Course title: Microprocessors Lab
Pre-requisite(s): Digital System Design, Computer Architecture
Co-requisite(s): Digital System Design
Credits: L:0 T:0 P:2 C:1.0
Class schedule per week: 02
Class: B. Tech.
Semester / Level: V/ 03
Branch: ECE

Course Objectives

This course enables the students to:

1.	To develop efficient 8085-based programs for different tasks.
2.	To develop efficient 8086-based programs for different tasks.
3.	To interface 8085 with peripheral devices for different tasks.
4.	To interface 8086 with peripheral devices for different tasks.
5.	To be able to develop microprocessor-based systems for industrial applications.

Course Outcomes

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

CO1	Demonstrate the programming concepts of 8085 and 8086 processors for efficient coding.
CO2	Show the interfacing of different peripherals with 8085 and 8086 processors
CO3	Analyze the output of different peripherals when programmed in different modes using 8085 and 8086 processors
CO4	Develop the interfacing circuits for different applications with appropriate peripherals.
CO5	Design 8085/8086 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, EC24305 Microprocessors is the syllabus for the EC24306 Microprocessors Lab. The following experiments are the guidelines for the students. However, the questions for exams are not limited to this experiment list.]

Experiment No.	**Name of the Experiments**
1.	**Write 8085/8086 based program and verify for** **a. Rearranging Bytes** **b. Formation of third block**
2.	**Write 8085/8086 based program and verify for** **a. Addition of two 20-digit Binary numbers** **b. Addition of two 20-digit BCD numbers**

3.	**Write 8085/8086 based program and verify for** **a. Multiplication of single byte by single byte** **b. division of single byte by single byte**
4.	**Write 8085/8086 based program and verify for** **a. Sorting of 16 bytes in ascending order** **b. Sorting of 16 bytes in descending order**
5.	**Write 8085/8086 based program and verify for** **a. ASCII character to HEX conversion** **b. Hex to BCD conversion**
6.	**Write 8085 based program and verify for** **a. Serial outputting at SOD pin of 8085** **b. Serial inputting via SID pin of 8085.**
7.	**Write 8085/8086 based program for interfacing the 8-bit ADC with the processor and acquiring of ADC data.**
8.	**Write 8085/8086 based program for the interfacing of DAC with the processor and generation of square, triangular, sinusoidal signals.**
9.	**Write 8085/8086 based program for the interfacing of stepper motor with the processor and clockwise and anticlockwise rotation of the motor.**
10.	**Write 8085/8086 based program for the interfacing of traffic lights and control using 8255 PPI.**
11.	**Write 8085/8086 based program for the interfacing of seven segment LED/LCD display with the processor.**
12.	**Write 8085 based program to display 'HELP US" using keyboard and display controller 8279.**

Books recommended:

Textbooks:

1. Microprocessor Architecture, Programming and Applications with 8085 by R. S. Gaonkar.
2. Advanced Microprocessors and Peripherals by K. M. Bhurchandi and A. K. Ray.

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): 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
Progressive Evaluation	**(60)**
Attendance	**12**
Day-to-day performance	**06**
Lab Viva	**20**
Lab file	**12**
Lab Quiz-I	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II	**10**
Lab Performance Test	**30**

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**	**1**	**2**	**3**
CO1	3	3	3	2	3	1	0	1	1	1	1	3	3	2
CO2	3	3	3	2	3	1	0	1	1	1	1	3	3	2
CO3	3	3	3	2	3	1	0	1	1	1	1	3	3	2
CO4	3	3	3	2	3	1	0	1	1	1	1	3	3	2
CO5	3	3	3	2	3	1	0	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:

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
Data Communication and Computer Networking

Course code: EC24307
Course title: Data Communication and Computer Networking
Pre-requisite(s): Fundamental of Communication
Co- requisite(s): NIL
Credits: L: 3 T: 1 P: 0 C:4
Class schedule per week: 04
Class: B. Tech.
Semester / Level: V/03
Branch: ECE

Course Objectives
This course enables the students:

1.	To build an understanding of the fundamental concepts of Data Communication. To justify the need of protocol and standards in data communication
2.	To analyze the performance of different flow control and error control mechanism and implement Error detection and correction scheme. Find out a suitable multiplexing scheme for effective utilization of the bandwidth.
3.	Understand the different network topologies, transmission media and different MAC sub-layers used in the design of a Local Area Network (LAN).
4.	Implement different routing algorithm on a given network
5.	Familiarize the layer of operation and working of different intermediate devices, network layer protocols, internet addressing mechanism and transport layer protocols

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

CO1	Define the protocols and standards used in data communication
CO2	Explain different Data link control techniques like, error detection, correction, flow control, error control and multiplexing
CO3	Recall the basic reference model of LAN, their topologies and different types of intermediate systems in a network used.
CO4	Implement different routing algorithm on a given network
CO5	Understand the basics of various internet and transport protocols and their functioning.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I Data communication model, Terminology used in Data communication (data rate, baud rate, channel capacity, SNR, E_b/N_0 ete), Topology and transmission media, Protocols: Need of protocol architecture, OSI and TCP/IP. Data encoding techniques (NRZ, Manchester, Differential Manchester, Bipolar AMI), Scrambling techniques. Error detection techniques like CRC, Error correction using Block code.	**8**

Module – II Data link control, Utilization efficiency, Flow control and error control, HDLC frame format and operation. Multiplexing: FDM, TDM fundamental. Statistical TDM, cable modem, ADSL.	**8**
Module – III LAN protocol, IEEE802 Reference model, Logical link control, Medium access control: ALOHA, CSMA, CSMA-CD, IEEE 802.3 Ethernet, token ring and FDDI. Connecting devices like Repeaters, hubs, bridges, routers etc.	**8**
Module – IV Packet Switching: Datagram packet switching and Virtual circuit Packet switching, Routing characteristics, Routing strategies, Use of Least cost algorithms like Dijkstra's and Bellman-Ford algorithms, ARPANET. Principles of Internetworking. IPV4, IP addressing scheme, Subnetting, IPV6, Comparison between IPV4 and IPV6, Interoperability between IPV4 and IPV6.	**8**
Module – V 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. Application layer protocols: SMTP, MIME, SNMP, HTTP	**8**

Textbooks:

1. Data and Computer Communication, 8/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
2. Computer Networking and Data Communication by S. S. Tripathy, AICTE, New Delhi

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 and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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	1	2	3
CO1	3	1	1	2	1	0	0	0	0	0	2	2	1	3
CO2	3	1	1	2	1	0	0	0	0	0	1	3	1	3
CO3	3	3	2	2	2	0	0	0	0	0	1	2	2	2
CO4	3	2	1	1	1	0	0	0	0	0	1	2	2	2
CO5	3	1	1	2	1	0	0	0	0	0	1	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	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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

Digital Signal Processing

Course code: **EC24351**
Course title: **Digital Signal Processing**
Pre-requisite(s): Signals and Systems
Co-requisite(s): None
Credits: L: 3 T: 1 P: 0 C: 4
Class schedule per week: 04
Class: B. Tech.
Semester / Level: VI/ 03
Branch: ECE

Course Objectives

This course enables the students:

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	Understand signal processing tools such as discrete Fourier transform, fast Fourier transform and z-transform for discrete time systems.
CO2	Comprehend the discrete-time systems using FIR and IIR structures.
CO3	Understand the analog and digital filter characteristics, functions and transformation techniques.
CO4	Design digital filters using IIR and FIR techniques.
CO5	Apply the concepts of digital signal processing for advanced applications.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I Introduction to Discrete-Time signals and system: Difference Equation, Analysis of LTI system in Z-domain, LTI system as frequency selective filter, Inverse system, Periodic convolution, Fast Fourier Transform (FFT) and its algorithms-Decimation in time and Decimation in frequency, Convolution using overlap add and save method.	**8**

Module – II Digital Filter Structures (FIR & IIR): Direct form I&II, cascade, parallel, ladder realization, lattice structure, quantization of filter coefficients, truncation and round-off effects.	**8**
Module – III Filter Function Approximations and Transformations: Review of approximations of ideal analog filter response, Butterworth filter, Chebyshev Type I & II, Elliptic filters. Frequency Transformations: Frequency transformation in analog domain, frequency transformation in digital domain.	**8**
Module – IV Design of IIR Filter: Design based on analog filter approximations, Impulse invariance method, Matched Z-transformation, Bilinear transformation. Design of FIR Filters: Symmetric and anti-symmetric 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.	**8**
Module – V Multi rate DSP, Decimators and Interpolators, Sampling rate conversion, multistage decimator and interpolator, Poly phase filters, Estimation of Spectra from finite-duration observations of signals, Introduction to TMSC6X DSP processor.	**8**

Books recommended:

Textbooks:

1. John G. Proakis, Dimitris G. Mamalakis, Digital Signal Processing, Principles, Algorithms and Applications, Pearson, Prentice Hall.
2. Alan V. Oppenheim Ronald W. Schafer, 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): NA

POs met through Gaps in the Syllabus: NA

Topics beyond syllabus/Advanced topics/Design: NA

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

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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	1	2	3
CO1	3	3	3	3	3	1	1	2	2	2	3	3	3	3
CO2	3	3	3	3	3	1	1	2	2	2	3	3	3	3
CO3	3	3	3	3	3	1	1	2	2	2	3	3	3	3
CO4	3	3	3	3	3	2	1	2	2	2	3	3	3	3
CO5	3	3	3	3	3	2	1	2	2	2	3	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, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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

Digital Signal Processing Lab

Course code: EC24352
Course title: Digital Signal Processing Lab
Pre-requisite(s): Signals and Systems
Co-requisite(s): Digital Signal Processing
Credits: L:0 T:0 P:2 C:1.0
Class schedule per week: 02
Class: B. Tech.
Semester / Level: VI/ 03
Branch: ECE and allied branches

Course Objectives

This course enables the 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 skills 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 various sets of signal processing problems using MATLAB.
CO5	Implementation of signal processing techniques in DSP processor.

SYLLABUS:

Experiment No.	Name of the Experiments
1.	**Familiarization with MATLAB. Generation of the following sequence and to plot them using MATLAB:** **a. Unit Sample Sequence, δ[n]** **b. Unit Step Sequence, u[n]** **c. Ramp Sequence** **d. Exponential Sequence** **e. Sine/ Cosine Sequence**
2.	**To generate the discrete time signal from analog signal using sampling theorem and analyse the aliasing effect.**
3.	**Verification of the following general properties of LTI system.** **a. Linearity** **b. Time-invariance**

4.	**Computation of the Linear Convolution and Correlation of two finite-length sequences and compare that with their theoretical evaluation.**
5.	**Obtain Inverse Z-Transforms using the Partial Fraction Expansion and test its stability.**
6.	**Cascade realization of the Linear-Phase FIR and IIR transfer functions using MATLAB.**
7.	**Find out the Circular Convolution of two periodic sequences and compare that with its theoretical evaluation.**
8.	**Computation of N-point DFT and FFT of the length-N sequence using MATLAB and implement using TMS DSP processor.**
9.	**Design of digital filter (LP/HP/BP) and evaluate its performance.**
10.	**To realize the decimation, interpolation and sampling rate conversion of a signal.**
11.	**To write a program and simulate using C language / assembly language for computation of Linear Convolution using TMS DSP Processor**
12.	**Implementation of digital filter (LP/HP/BP) using TMS DSP Processor.**

List of optional experiments:

1. To develop a MATLAB program to convert Analog to Digital Frequencies using Bilinear Transformation.
2. To design a Butterworth filter using standard design steps (for LP, HP, BP & 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.
3. To design a Chebyshev filter using standard design steps (general programs for LP, HP, BP & BR filter design)

Text books:

1. Getting Started with MATLAB by Rudra Pratap, 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:

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

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
Progressive Evaluation	**(60)**
Attendance	**12**
Day-to-day performance	**06**
Lab Viva	**20**
Lab file	**12**
Lab Quiz-I	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II	**10**
Lab Performance Test	**30**

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**	**1**	**2**	**3**
CO1	3	3	3	3	3	2	0	1	2	3	3	3	3	3
CO2	3	3	3	3	3	2	0	1	2	3	3	3	3	3
CO3	3	3	3	3	3	2	0	1	2	3	3	3	3	3
CO4	3	3	3	3	3	2	0	1	2	3	3	3	3	3
CO5	3	3	3	3	3	2	0	1	2	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 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, CD3, CD5, CD9
CD2	Tutorials/Assignments	CO2	CD1, CD3, CD5, CD9
CD3	Seminars/ Quiz (s)	CO3	CD1, CD3, CD5, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD3, CD5, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD3, 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

Control Systems

Course code: EC24353
Course title: Control Systems
Pre-requisite(s): Mathematics, Signals and Systems
Co- requisite(s): N/A,
Credits: L: 3 T: 1 P: 0 C:4
Class schedule per week: 04
Class: B. Tech.
Semester / Level: VI/03
Branch: ECE

Course Objectives
This course enables the students:

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)**
Module – I **MODULE – I** 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. Mechanical systems, Electrical systems and their analogy.	**6**

Module – II 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.	**10**
Module – III 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.	**8**
Module – IV 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 observable State models, Asymptotic state observers. Control system design via pole placement. Design of P, PI, PD and PID controllers.	**10**
Module – V 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.	**6**

Books recommended

Textbooks:

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: 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	1	2	3
CO1	2	2	3	3	2	3	2	3	3	3	3	3	3	2
CO2	2	2	3	3	2	3	2	3	3	3	3	3	3	2
CO3	2	2	3	3	2	3	3	3	3	3	3	3	3	2
CO4	2	2	3	3	2	3	2	3	3	3	3	3	3	2
CO5	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, CD2, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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
Embedded Systems

Course code: EC24355
Course title: Embedded Systems
Pre-requisite(s): Microprocessors
Co- requisite(s): N/A
Credits: L: 3 T: 0 P: 0 C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VI/03
Branch: ECE

Course Objectives:
This course enables the students:

1.	To understand the principles of hardware-software co-design, system integration, and design challenges in embedded systems.
2.	To provide knowledge of microcontroller and processor architectures, including instruction sets, memory management, and peripheral interfacing.
3.	To equip students with the skills to design, simulate, and implement embedded systems using platforms like FPGA and integrate IoT solutions.
4.	To understand and implement communication protocols (UART, I2C, SPI, CAN), interface sensors, actuators, and other peripherals.
5.	To design, simulate, and implement embedded systems using platforms like FPGA.

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

CO1	Explain the principles of embedded system design, including hardware-software co-design and system-level integration.
CO2	Develop and execute embedded system programs using microcontrollers and processors, implementing peripherals and communication protocols.
CO3	Evaluate the requirements for interfacing sensors, actuators, and communication modules to meet specific system needs.
CO4	Assess the performance of embedded systems using RTOS features like multitasking, IPC, and task scheduling.
CO5	Design, simulate, and implement advanced embedded applications using FPGA platforms and IoT technologies.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction to Embedded Systems** Definition and Characteristics of Embedded Systems, Embedded System vs General-Purpose System, Classification, Design metrics and challenges, Embedded system design using 8051 microcontrollers, Instruction set, Timer and Counters, Watchdog Timer, Real Time Clock, Interrupt handling	**8**

Module – II **Introduction to ARM Interconnect Interface** The ARM Processor Architecture: History and Key Features, AMBA (Advanced Microcontroller Bus Architecture) Overview, Evolution and Purpose, AHB (Advanced High-performance Bus) / APB (Advanced Peripheral Bus) – Basics, AXI (Advanced Extensible Interface) Read/Write Channels, Pipelining, Burst Transactions, AXI vs. AHB vs. APB Comparison, ACE (AXI Coherency Extensions) – Basic Overview, CHI (Coherent Hub Interface) – Brief Introduction	**8**
Module – III **Interfacing and Communication Protocols** PWM interface, Bus Arbitration, On Board Buses- I2C and SPI, Off Board Bus – CAN, Ethernet, and Wi-Fi.	**8**
Module – IV **Real-Time Operating Systems (RTOS)** Concept of Real-Time Systems, RTOS Architecture and Kernel, Task Scheduling, Multitasking, and Inter-Process Communication (IPC), Real-Time Task Synchronization and Deadlock Handling, Case Study of Free RTOS and VxWorks	**8**
Module – V **FPGA-based Embedded System** Introduction to FPGA, FPGA architecture, Applications of FPGA (Mux, Decoder, ALU, Adder, SSD, Counter, Register), IoT interfacing	**8**

Textbooks:

1. “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”, Mazidi Muhammad Ali, 2nd edition, Pearson Education India
2. “Embedded Systems: Introduction to ARM Cortex-M Microcontrollers”, Jonathan W. Valvano, 5th edition, CreateSpace
3. “Embedded Systems-Architecture, Programming, and Design”, Rajkamal, 3rd edition, TMH.

Reference books:

1. “Embedded Systems: A Contemporary Design Tool”, James K Peckol, 2nd edition, Wiley
2. “Embedded System Design”, Santanu Chattopadhyay, 2nd Edition, PHI.
3. “Embedded Systems: An Integrated Approach”, Lyla B Das, 1st edition, Pearson Education India

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 and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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**	**1**	**2**	**3**
CO1	3	3	2	2	3	1	0	0	1	1	1	3	3	2
CO2	3	3	2	2	3	1	0	0	1	1	1	3	3	2
CO3	3	3	2	2	3	1	0	0	1	1	1	3	3	2
CO4	3	3	2	2	3	1	0	0	1	1	1	3	3	2
CO5	3	3	2	2	3	1	0	0	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

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	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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

Embedded Systems Lab

Course code: EC24356
Course Title: Embedded Systems Lab
Pre-requisite(s): Microprocessors
Co-requisite(s): Embedded Systems
Credits: L:0 T:0 P:2 C:1.0
Class schedule per week: 02
Class: B. Tech.
Semester / Level: VI/ 03
Branch: ECE

Course Objectives
This course enables the students:

1.	To understand the fundamental principles of embedded systems includes hardware-software design and system integration.
2.	To gain practical experience in programming microcontrollers.
3.	To develop skills to interface and control hardware peripherals such as sensors, actuators, and communication modules.
4.	To gain experience in working with embedded communication protocols such as UART, SPI, and I2C.
5.	To design, simulate, and implement embedded systems using FPGA platforms.

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

CO1	Demonstrate an understanding of the hardware-software co-design process and effectively integrate components into a functional embedded system.
CO2	Develop and execute microcontroller programs to perform specific embedded tasks.
CO3	Analyze system requirements and design solutions to interface and control hardware peripherals.
CO4	Implement communication protocols and evaluate their effectiveness in transferring data within an embedded system.
CO5	Design, simulate, and construct digital systems using FPGA platforms and hardware description languages.

Experiment No.	**Name of the Experiments**
	Basic Arduino Programming & Digital I/O Control
1.	**i) Write, compile, and run simple programs (e.g., blinking LED) using the development environment and Arduino.** **ii) Control LEDs or read inputs from push buttons using an Arduino microcontroller. Implement a basic logic using a toggle switch or binary counter.**

Display Interfaces with Microcontrollers	
2.	i) **Write a program to display numbers or characters on a 7-segment display connected to the Arduino.** ii) **Write a program to display numbers or characters on a 7-segment display connected to the Arduino using an external Keyboard.**
Analog Sensors & Actuators Interfacing	
3.	**i) Interface a DC /Servo with the microcontroller and control its speed using PWM signals. Use an optical / potentiometer sensor for the measurement of the speed.** **ii) Interface a potentiometer or temperature sensor with the ADC pin of a microcontroller and display the converted values (in °C) on an LCD of size 16 x 2.**
Communication Protocols & Data Logging	
4.	**i) Interface a temperature and humidity sensor (e.g., BMP180, DHT22) / RTC (Real-Time Clock) module with the microcontroller using I^2C and display the sensor data/ date and time on an LCD.** ii) **Interface an SD card with a microcontroller using SPI and log sensor data (e.g., temperature or humidity) into a text file on the SD card using the above setup.**
Wireless Communication & IoT Applications	
5.	**i) Set up two microcontrollers to communicate wirelessly using ZigBee/Bluetooth modules and send the measured distance by the ultrasonic sensor.** **ii) Use an ESP8266 or ESP32 Wi-Fi module to send sensor data (e.g., temperature) to a computer/mobile phone.**
Real-Time Operating System	
6.	**Use an RTOS (e.g., Free RTOS) to create multiple tasks like blinking an LED while reading sensor data in parallel on a microcontroller like ARM Cortex-M.**
FPGA-Based Implementations	
7.	**Design a 4-bit ALU to implement addition, subtraction, complement, AND, OR operations on the FPGA board.**
8.	**Design a pre-settable 8-bit counter on the FPGA board.**

Books recommended:

Textbooks:

1. "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Mazidi Muhammad Ali, 2nd edition, Pearson Education India
2. "Embedded Systems: Introduction to ARM Cortex-M Microcontrollers", Jonathan W. Valvano, 5th edition, CreateSpace

3. "Embedded Systems-Architecture, Programming, and Design", Rajkamal, 3rd edition, TMH.

Reference books:

1. "Embedded Systems: A Contemporary Design Tool", James K Peckol, 2nd edition, Wiley
2. "Embedded System Design", Santanu Chattopadhyay, 2nd Edition, PHI.
3. "Embedded Systems: An Integrated Approach", Lyla B Das, 1st edition, Pearson Education India

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
Progressive Evaluation	**(60)**
Attendance Marks	**12**
Day-to-day performance Marks	**06**
Lab Viva marks	**20**
Lab file Marks	**12**
Lab Quiz-I Marks	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II Marks	**10**
Lab performance Marks	**30**

Indirect Assessment –

1. Student Feedback on Course Outcome

Mapping of Course Outcomes into Program Outcomes

Course Outcome	**Program Outcomes (POs)**											**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	3	3	3	2	3	1	0	1	1	1	1	3	3	2
CO2	3	3	3	2	3	1	0	1	1	1	1	3	3	2
CO3	3	3	3	2	3	1	0	1	1	1	1	3	3	2
CO4	3	3	3	2	3	1	0	1	1	1	1	3	3	2
CO5	3	3	3	2	3	1	0	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:

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
Microwave Theory and Techniques

Course code: EC24401
Course title: Microwave Theory and Techniques
Pre-requisite(s): Electromagnetic Fields and Waves.
Co- requisite(s): Microwave Engineering Lab
Credits: L: 3 T: 1 P: 0 C:4
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VII/03
Branch: ECE

Course Objectives

This course enables the students:

1.	To develop ability to explain the concept of various performance parameters used for microwave networks, devices and components.
2.	To describe the principles of various microwave amplifiers and oscillators
3.	To develop ability to evaluate the performance of various microwave networks
4.	To develop ability to design the various microwave devices and components
5.	To develop ability to design the ferrimagnetic based microwave components

Course Outcomes

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

CO1	Understand the various performance parameters used for microwave networks, components and devices.
CO2	Characterize the features of various microwave amplifiers and oscillators.
CO3	Evaluate the performance of various microwave networks and components.
CO4	Design the various microwave devices and components.
CO5	Design the ferrimagnetic based microwave components

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction to Microwave and Microwave Network Analysis:** Microwave Frequency bands, Applications of Microwaves, Equivalent Voltages and currents, Impedance and Admittance Matrices, Scattering Parameters, The Transmission (ABCD) Matrix.	**8**

Module – II **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.	**8**
Module – III **Microwave Filters:** Filter Types and parameters, Realization of Butterworth and Chebyshev type filter, Filter Implementation.	**8**
Module – IV **Microwave Tubes:** Limitations and Losses of conventional Tubes at Microwave Frequencies, Klystron, Reflex Klystron, Travelling Wave Tube, Magnetron.	**8**
Module – V **Design of Ferrimagnetic Components:** Intro to Ferrimagnetic Material, Faraday rotation in ferrite, Ferrite Isolators, Ferrite Phase Shifters, Ferrite Circulators.	**8**

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, “ Intoduction 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 real-time 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: PO6, PO8

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

Direct Assessment

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

Assignment	10
Teacher's Assessment	05
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	1	2	3
CO1	3	3	3	3	3	2	1	2	1	2	3	3	3	3
CO2	3	3	3	3	3	2	1	2	1	2	3	3	3	3
CO3	3	3	3	3	3	2	1	2	1	2	3	3	3	3
CO4	3	3	3	3	3	2	1	2	1	2	3	3	3	3
CO5	3	3	3	3	3	2	1	2	1	2	3	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, 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

Microwave Lab

Course code: EC24402
Course title: Microwave Lab
Pre-requisite(s): Electromagnetic Fields and Waves
Co- requisite(s): Microwave Theory and Techniques
Credits: L: 0 T: 0 P: 2 C:1
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VII/04
Branch: ECE

Course Objectives

This course enables the students:

1.	To develop an understanding about the measurements of the various microwave passive components.
2.	To determine the performance parameters of microwave crystal detector.
3.	To design and study the performance of a planar microwave LP filter.
4.	To design and analyze a planar microstrip quadrature hybrid coupler.
5.	To design and evaluate a microstrip planar power divider

Course Outcomes

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

CO1	Understand the measurement techniques of the various microwave passive components.
CO2	Determine the performance parameters of microwave crystal detector.
CO3	Design and study the performance of a planar microwave LP filter.
CO4	Design and analyze a planar microstrip quadrature hybrid coupler.
CO5	Design and evaluate a microstrip planar power divider.

SYLLABUS

Experiment No.	**Name of the Experiments**
(A) HARDWARE BASED EXPERIMENTS	
1.	**Determine the rectangular waveguide parameters.**
2.	**Find out the coupling coefficients of E-plane and H-plane Tee.**

3.	**Find out the coupling coefficients and isolation of Magic Tee.**
4.	**Find out the coupling factor, directivity and insertion loss of a multi hole direction coupler.**
5.	**Find out the coupling coefficients and isolation of a three-port circulator.**
6.	**Find out the isolation of an isolator and amount of phase shift of a phase shifter.**
7.	**Determine the attenuation of a variable microwave attenuator.**
8.	**Examine the square law characteristics of a microwave crystal detector.**
(B) SOFTWARE BASED EXPERIMENTS	
9.	**Design a 50-ohm microstrip transmission line using IE3D software**
10.	**Design a microstrip low pass filter for the given specifications using the IE3D.**
11.	**Design a 50 Ω branch-line quadrature hybrid junction and plot the scattering parameter magnitudes for given frequency using the IE3D.**
12.	**Design a 3 dB equal power divider and plot the scattering parameter magnitudes for given frequency using the IE3D.**

Text Books:

1. “David M. Pozar, "Microwave Engineering", Third Edition, Wiley India.

Reference Book:

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): 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
Progressive Evaluation	**(60)**
Attendance Marks	**12**
Day-to-day performance Marks	**06**
Lab Viva marks	**20**
Lab file Marks	**12**
Lab Quiz-I Marks	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II Marks	**10**
Lab performance Marks	**30**

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**	**1**	**2**	**3**
CO1	3	3	2	1	3	2	1	1	3	2	2	2	2	3
CO2	3	3	2	1	3	2	1	1	3	1	2	2	2	3
CO3	3	3	3	2	3	2	1	1	3	1	3	2	2	3
CO4	3	3	3	2	3	2	1	1	3	1	3	2	2	3
CO5	3	3	3	2	3	2	1	1	3	1	3	2	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, 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

Information Theory and Coding

Course code: EC24309
Course title: Information Theory and Coding
Pre-requisite(s): Digital Electronics, Probability Theory, Communication system.
Co-requisite(s): None
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: V/ 03
Branch: Branch: ECE

Course Objectives

This course envisions to impart students to:

1	Develop an understanding on information coding fundamentals with several source coding techniques for efficient representation of a source.
2	Develop an understanding of channel capacity and foundation of channel coding techniques to achieve efficient as well as reliable communication.
3	Have fundamental knowledge on block codes, cyclic codes and convolutional codes with its practical challenges.
4	Think and apply the concept of appropriate coding algorithms for several applications in the field of communication.
5	Enhance critical thinking and develop an ability to provide design solutions for practical low cost, efficient, reliable as well as secure communication system.

Course Outcomes

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

CO1	Explain fundamentals of several lossy & lossless source coding techniques and further elaborate its possible extension in practical scenarios.
CO2	Elaborate the concept of channel capacity for several noisy channels, block codes, bounds for block codes and design aspects of linear block codes with its encoding as well as decoding.
CO3	Demonstrate the fundamentals of cyclic codes and convolutional codes with its circuit implementation. The students will be able to analyze various advance channel coding techniques.
CO4	The students will be able to apply several source coding techniques, encryption-decryption techniques and advance channel coding techniques to provide efficient, secure and reliable communication of a discrete/ continuous message source.
CO5	Have an ability to provide practical solutions and apply the subject expertise for the welfare of the society.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Source Coding:** Introduction to information, Information measure, Entropy, Differential Entropy, Conditional Entropy, Relative Entropy, Information rate, Mutual Information, Shannon's Source Coding Theorem, Prefix Coding, Huffman Coding, Shannon-Fano Coding, Arithmetic Coding, Lempel Ziv Algorithm, Rate Distortion Theory.	**10**
Module – II **Channel Capacity & Coding:** 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.	**8**
Module – III **Block Codes:** Galois Fields, Hamming Weight and Hamming Distance, Linear Block Code, Encoding and decoding of Linear Block-codes, Parity Check Matrix, Bounds for block codes, Hamming Codes, Syndrome Decoding.	**8**
Module – IV **Cyclic Codes:** Introduction to cyclic code, Method for generating Cyclic Codes, Matrix description of Cyclic codes, Cyclic Redundancy Check (CRC) codes, Circuit implementation cyclic codes, Burst error correction, BCH code and Reed-Soloman Code.	**8**
Module – V **Convolutional Codes:** Introduction to Convolutional Codes, Polynomial description of Convolutional Code, Generating function, Matrix description of Convolutional Codes, Viterbi Decoding Convolutional code, Introduction to Turbo Code and LDPC Code.	**8**

Textbooks:

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-Interscience Publication.
2. "Error Correction Coding Mathematical Methods and Algorithms" by Todd K. Moon, WileyIndia Edition.

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

Applications of digital image 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: PO2

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	10
Teacher's Assessment	05
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes into Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	3	1	0	0	0	1	0	0	0	0	1	3	2	1
CO2	3	3	1	0	0	1	0	0	0	0	1	3	2	2
CO3	3	3	2	1	0	0	0	0	0	0	0	3	2	1
CO4	3	3	2	3	0	0	0	0	0	0	2	3	2	3
CO5	3	3	1	3	2	1	0	0	0	0	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, 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
ASIC Design

Course Code: EC24311
Course Title: ASIC Design
Pre-requisite(s): VLSI Design
Co-requisite(s): NA
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VII/4
Branch: Electronics & Communication Engineering

Course Objectives

This course enables the students to:

1.	Understand the fundamentals of Verilog for semi-custom IC Design.
2.	Synthesize and Analyze Verilog models for semi-custom IC Design.
3.	Model combinational and sequential circuits.
4.	Optimize designed models for semi-custom IC Design.
5.	Understand the fundamentals of SystemVerilog for semi-custom IC Design.

Course Outcomes

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

CO1	Recognize the importance of Semicustom ICs Design.
CO2	Explain HDL language constructs.
CO3	Apply acquired knowledge to design optimized combinational and sequential processing unit for customized system.
CO4	Develop hardware optimized secure system for various applications.
CO5	Design digital system for solving day-to-day life problems.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction to Verilog**: History of Verilog, design methodology, abstraction level, data type, identifiers and keywords, switch-level modeling, gate-level (or structural) modeling, dataflow modeling, behavioral modeling, and structured procedures.	**8**
Module – II **Synthesis, and Analysis**: continuous assignment statement, procedural assignment statement, blocking and non-blocking statements, logical operator, arithmetic operator, relational operators, shift operators, vector	**8**

operations, Bit-selects, if statement, case statement, Always Statement, IF Statement, loop statement, latch with preset and clear, modeling flip-flops, modeling of a decoder, modeling of a multiplexer.	
Module – III **Modeling of combinational and sequential circuits**: Modeling memory, modeling Gray code to Binary code converter, modeling an FSM and universal shift register, modeling a counter, modeling of the parameterized adder, modeling of the parameterized comparator, modeling parameterized parity generator, modeling a three-state gate, modeling factorial, modeling a counter and ALU.	**8**
Module – IV **Model Optimization**: Resource allocation, common sub-expressions, moving code, common factoring, commutativity and associativity, Test Bench and its application.	**8**
Module – V **Introduction to SystemVerilog:** Verification Guidelines, Data Types, Procedural Statements and Routines, Connecting the Testbench and Design, Design examples of Inverters connected to an 8-bit bus, an 8-bit NAND, an 8-bit pseudo-NMOS NOR, 8-bit resettable Synchronous and Asynchronous Register, 8-bit Shift Register with Parallel Load, 32-bit adder, Basic concept of Object-Oriented Programming.	**8**

Textbooks:

1. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis,” SunSoft Press, 1996.
2. Spear, Chris “SystemVerilog for Verification: A Guide to Learning the Testbench Language Features”, 2nd ed., Norwell, MA, Springer 2006.

Reference Books:

1. Neil H. E. Weste, David Money Harris, “CMOS VLSI Design – A Circuits and Systems Perspective,” 4th ed., Addison Wesley, 2011.
2. Morris Mano, Michael D. Ciletti, “Digital Design: With an Introduction to the Verilog HDL”, 5th Edition, Prentice Hall, 2013.
3. Stuart Sutherland, Simon Davidmann, Peter Flake, “SystemVerilog Design - A Guide to Using SystemVerilog for Hardware Design and Modeling,” 2nd ed., Springer, 2006.

Gaps in the syllabus (to meet Industry/Profession requirements): Hands-on-practical for CMOS IC (Integrated Circuit) fabrication.

POs met through Gaps in the Syllabus: NA

Topics beyond syllabus/Advanced topics/Design: NA

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

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

Direct Assessment

Exam	**Components**	Marks	Total Marks
Internal Evaluation	A. First Quiz	10	50
	B. Mid Semester Examination	25	
	C. Assignment	10	
	D. Teacher's Assessment	5	
End Semester Examination		50	50
		Total	100

Indirect Assessment

1. Student Feedback on Faculty

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**	**1**	**1**	**1**	**2**	**3**
CO1	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO2	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO3	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO4	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO5	3	3	1	2	3	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, CD4, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD4, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD4, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD4, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2, CD3, CD4, CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as the use of NPTEL Materials and Internet		
CD9	Simulation		

COURSE INFORMATION SHEET

Artificial Intelligence and Machine Learning

Course Code: EC24313
Course Title: Artificial Intelligence and Machine Learning
Pre-requisite(s): Linear Algebra, Probability Theory
Co- requisite(s):
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: V/03
Branch: ECE

Course Objectives

This course enables the students to:

1.	Introduce AI/ML concepts, history, and applications in electronics and communication.
2.	Build a foundation in linear algebra, probability, and mathematical principles for ML.
3.	Explore various machine learning techniques.
4.	Implement various machine learning model for different applications.
5.	Learn the use of different AI/ML tools like TensorFlow and PyTorch to solve various ML problems

Course Outcomes

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

CO1	Understand AI/ML concepts, applications, and ethical implications.
CO2	Apply mathematical methods to understand and optimize ML models.
CO3	Implement various machine learning models.
CO4	Evaluate models' performance through various evaluation metrics.
CO5	Apply different AI/ML tools to build models for solving engineering problems.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I Definition and history of AI, Applications of AI in electronics and communications, Components of AI: Knowledge representation, Reasoning, Problem solving, Search Techniques; Ethical and social considerations of AI, Introduction to machine learning, Types of Machine Learning: Supervised and Unsupervised and Reinforcement learning.	**8**

Module – II Linear Algebra: Matrix and Tensor, Norms, Eigen decomposition. Probability: Probability distribution function, Marginal and conditional probability, Expectation maximization, Variance and Covariance, Bayes Rule. Problem formulation in ML, Overfitting and underfitting, Hyperparameter tuning.	**8**
Module – III Clustering techniques: K-means clustering, DBSCAN, Hierarchical clustering, Mean-shift clustering. Dimensionality reduction: PCA, Factor analysis.	**8**
Module – IV Introduction to classification and regression. Regression techniques: Linear regression, Logistic regression, Support Vector regression. Classification techniques: Bayes, Decision trees and Random Forest; Boosting and bagging techniques, GMM and HMM, k-nearest neighbours (KNN), Support Vector Machines (SVMs). Evaluation metrics: Precision, Recall, ROC curve, bias-variance tradeoff.	**8**
Module – V Introduction to reinforcement learning; Markov Decision Process, Q-Learning, Deep Q-Learning. Tools for AI/ML: TensorFlow, Keras, PyTorch, Scikit-learn.	**8**

Text Books:

1. **"Artificial Intelligence: A Modern Approach"** by Stuart Russell and Peter Norvig
2. "**Pattern Recognition and Machine Learning**" by Christopher M. Bishop Publisher: Springer

Reference Books:

1. **“Introduction to Machine Learning with Python: A Guide for Data Scientists"** by Andreas C. Müller and Sarah Guido
2. **"Reinforcement Learning: An Introduction"** by Richard S. Sutton and Andrew G. Barto

Gaps in the Syllabus (to meet Industry/Profession requirement: 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 and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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**	**1**	**2**	**3**
CO1	3	2	2	1	2	2	2	3	1	2	1	2	2	1
CO2	3	3	2	2	2	1	1	1	1	2	1	3	3	2
CO3	2	2	3	3	2	1	1	1	2	3	1	3	3	2
CO4	2	2	2	3	2	1	1	1	2	3	1	2	3	2
CO5	3	2	3	2	3	2	2	2	3	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, CD2, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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
Fiber Optic Communication

Course code: **EC24357**
Course title: **Fiber Optic Communication**
Pre-requisite(s): Basic Electronics, Electronic Devices, Communication
Co-requisite(s): None
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VI/03
Branch: ECE

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	Understand the working of optical fibers, light sources and photodetectors
CO2	Understand the working of optical receiver, optical coupler, optical switches and optical amplifiers
CO3	Evaluate the fiber optic communication system performance in terms of attenuation, dispersion and overall loss budget
CO4	Comprehend the working of WDM system, optical networks and scattering effects in non-linear medium
CO5	Design fiber optic system for various applications.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Generations of optical communication, Fiber types and fiber parameters, Fiber material and fabrication methods, Ray analysis in Step Index (SI) and Graded index (GI) fibers, Modes in SI fiber, Power flow in step index fibers, Attenuation and Dispersion effects in optical fibers.	**8**
Module – II 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, Splicing techniques and OTDR	**8**
Module – III Principle of PIN Photodiode and Avalanche Photodiode, Noise in photodetectors, Detector response time, Optical receiver configuration and performance, Pre-amplifier design for optical receiver, Optical link design, Point-to-point transmission links, Link power and rise time budget.	**8**
Module – IV Optical switches, 2x2 Optical couplers, WDM and DWDM operational principles, Optical amplifiers, Semiconductor optical amplifier (SOA) and Erbium doped fiber amplifier (EDFA), EDFA architecture, Fiber Bragg grating, Add/Drop Multiplexer, Wavelength converters.	**8**
Module – V SONET/ SDH architecture, SONET/ SDH Rings, All optical WDM networks, Single-hop and Multi-hop networks, Nonlinear effects on network performance, SRS, SBS, Self-phase modulation (SPM), Soliton based communication.	**8**

Text books:

1. “Optical Fiber Communications” G.Keiser, 3/e, McGraw Hill
2. “Optical Fiber Communication”,J. M. Senior, PHI,2nd 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 Kolimbiris, 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): NA

POs met through Gaps in the Syllabus: NA

Topics beyond syllabus/Advanced topics/Design: NA

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

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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	1	2	3
CO1	3	3	3	3	3	1	0	1	1	2	2	2	2	2
CO2	3	3	3	3	3	1	0	1	1	2	2	2	2	2
CO3	3	3	3	3	3	1	0	1	1	2	2	2	2	2
CO4	3	3	3	3	3	1	0	1	1	2	2	2	2	2
CO5	3	3	3	3	3	1	0	1	1	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

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	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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
Fiber Optic Communication Lab

Course code: **EC24358**
Course title: **Fiber Optic Communication Lab**
Pre-requisite(s): Basic Electronics, Electronic Devices, Communication
Co- requisite(s): Fiber Optic Communication
Credits: L: 0 T: 0 P: 2 C: 1.0
Class periods per week: 02
Class: B. Tech.
Semester / Level: VI/03
Branch: ECE

Course Objectives
This course enables the students to

1.	Demonstrate fiber optic analog link and digital link without and with multiplexing.
2.	Illustrate fiber attenuation, coupling losses and numerical measurement.
3.	Inspect different modulation formats in fiber optic link.
4.	Design of optical fiber and characterize optical amplifier.
5.	Realize wavelength division multiplexing and de-multiplexing in fiber optic link.

Course Outcomes

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

CO1	Comprehend optical source, detector, single mode and multimode fibers, and measure optical fiber parameters.
CO2	Choose the modulation techniques for the short haul and long-haul fiber optic link.
CO3	Apply multiplexing techniques, and coding schemes in analog and digital fiber optic link.
CO4	Design optical gratings using FBGs and characterize optical amplifier.
CO5	Design electro-optic modulator based on Mach-Zehnder interferometer

SYLLABUS:

Experiment No.	Name of the Experiments
1.	**Study of Characteristics of Optical Source (LED) and Photodetector (Phototransistor/ Photodiode).**
2.	**Measurement of Numerical Aperture (NA) of a multimode plastic fiber and measurement of fiber attenuation of a plastic fiber.**
3.	**Realization of PWM and PPM in fiber optic link.**

4.	**Realization of Digital Time Division Multiplexing and study of framing in fiber optic link.**
5.	**Realization of Manchester Coding and Decoding in optical fiber link.**
6.	**Measurement of Bit Error Rate (BER) and study of EYE-Pattern in optical fiber link.**
7.	**Realization of Wavelength Division Multiplexing and De-multiplexing in fiber optic communication system.**
8.	**Excitation of LP modes (LP_{01}, LP_{11}, LP_{02}) and to find their power distributions in the Core and Cladding of optical fiber using BeamProp (RSoft) software.**
9.	**Implementation of a Mach-Zehnder Electro-Optic Modulator (EOM) and plotting of the Power Output vs. Applied Voltage using BeamProp (RSoft) software.**
10.	**Implementation of technique of Manchester Coding and Decoding in optical fiber link using Optisystem (Optiwave) software.**
11.	**Design of Fiber Bragg Grating (FBG) and Long Period Grating (LPG) using GratingMOD (RSoft) software.**
12.	**Characterization of Erbium Doped Fiber Amplifier (EDFA).**

Textbook:

1. “Optical Fiber Communications” G. Keiser, 3/e, McGraw Hill

Reference Book:

1. “Introduction to Fiber Optics”, Ghatak &Thyagarajan, Cambridge University Press.

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

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 Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	**(60)**
Attendance	**12**
Day-to-day performance	**06**
Lab Viva	**20**
Lab file	**12**
Lab Quiz-I	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II	**10**
Lab Performance Test	**30**

Indirect Assessment

1. Student Feedback on Course

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**	**1**	**2**	**3**
CO1	3	3	3	3	3	1	0	1	1	2	2	2	2	2
CO2	3	3	3	3	3	1	0	1	1	2	2	2	2	2
CO3	3	3	3	3	3	1	0	1	1	2	2	2	2	2
CO4	3	3	3	3	3	1	0	1	1	2	2	2	2	2
CO5	3	3	3	3	3	1	0	1	1	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:

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD3, CD5, CD9
CD2	Tutorials/Assignments	CO2	CD1, CD3, CD5, CD9
CD3	Seminars/ Quiz (s)	CO3	CD1, CD3, CD5, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD3, CD5, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD3, 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
Wireless Communication

Course code: EC 24359
Course title: Wireless Communication
Pre-requisite(s): Analog and Digital Communication
Co- requisite(s): Nil
Credits: L:3 T:0 P:0 C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VI/03
Branch: ECE

Course Objectives

This course enables the students:

1	To understand the functioning of Wireless Communication systems, EM spectrum and comprehend the future vision on wireless communication.
2	To understand the working of various Wireless Communication Systems and know the various Wireless Standards
3	To figure out various kinds of Wireless Communication Networks and their applications.
4	To understand Wireless Channels and Basic Propagation Mechanisms also analyse Channel Impairments Removal Techniques.
5	To know and how to evaluate the Coding for Wireless Channels, Diversity Mechanisms and Combining Techniques and AI enabled wireless networks.

Course Outcomes

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

CO1	Demonstrate an understanding on functioning of Wireless Communication system, EM spectrum and future vision on wireless communication.
CO2	Explain working of various Wireless Communication Systems and Wireless Standards.
CO3	Explain various kinds of Wireless Communication Networks and their applications.
CO4	Explain Wireless Channels and Basic Propagation Mechanisms also analyse Channel Impairments Removal Techniques.
CO5	Evaluate Coding for Wireless Channels, Diversity Mechanisms and Combining Techniques and AI enabled wireless networks.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module–I **Introduction to Wireless Communication:** An Overview of Wireless Communication, Historical Developments in Wireless Communication, Future Vision, EM Spectrum, Basic Components of Wireless Communication System.	6

Module–II **Wireless Communication Systems and Standards**: Satellite Communication System, Global Positioning System, Paging System, Cordless Phone, Wireless Local Loop, RFID, Mobile Cellular Communication (Different Generations and Typical Examples).	10
Module–III **Wireless Communication Networks:** 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, AI enabled wireless networks.	10
Module–IV **Wireless Signal Propagation and Fading:** Noise and interference, Basic Propagation Mechanisms. Wireless Channel Models, Fading in Wireless Mobile Environment, Classification of Wireless Mobile Channels.	7
Module–V **Channel Impairments Removal Techniques:** Diversity Mechanisms and Combining Techniques (SC, TC, MRC, EGC), Equalization, Coding for Wireless Channels, Multicarrier system.	7

Textbooks:

1. Sanjay Kumar, "Wireless Communication the Fundamental and Advanced Concepts" River Publishers, Denmark, 2015 (Indian reprint).

Reference Books:

1. Vijay K Garg, "Wireless Communications and Networks", Morgan Kaufmann Publishers an Imprint of Elsevier, USA 2009 (Indian reprint)
2. Simon Haykin and Michael Moher, "Modern Wireless Communications", Parson Education, Delhi, 2005

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

POs met through Gaps in the Syllabus: NA

Topics beyond syllabus/Advanced topics/Design: NA

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

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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**	**1**	**2**	**3**
CO1	3	3	3	1	1	1	0	1	2	1	2	3	2	2
CO2	3	3	3	1	1	1	0	1	2	1	2	3	2	2
CO3	3	3	3	2	2	1	0	1	2	1	2	3	2	2
CO4	3	3	3	3	3	1	0	1	2	1	2	3	3	3
CO5	3	3	3	3	3	1	0	1	2	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
CD1	Lecture by use of Boards/LCD Projectors
CD2	Tutorials/Assignments
CD3	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 INFORMATION SHEET
Wireless Communication Lab

Course code: **EC24360**
Course title: **Wireless Communication Lab**
Pre-requisite(s): Communication
Co- requisite(s): Wireless Communication
Credits: L: 0 T: 0 P: 2 C: 1.0
Class periods per week: 02
Class: B. Tech.
Semester / Level: VI/03
Branch: ECE

Course Objectives

This course enables the students to:

1.	Develop an ability to design various kind of wired/wireless networks using network simulator.
2.	Evaluate the impact of mobility on network performance under Ad hoc mode scenario as well infrastructure mode scenario.
3.	Develop an ability to evaluate and compare the performance of several routing protocols, multicasting.
4.	Enhance the ability to examine the hardware setup for wireless sensor network.
5.	Develop an ability to configure and setup the 5G NR private network.

Course Outcomes

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

CO1	Design various kinds of wired/wireless networks.
CO2	Analyse the impact of mobility on network performance for Ad-hoc as well as infrastructure based network scenario.
CO3	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.
CO4	Examine the hardware setup for RFID and wireless sensor network.
CO5	Configure and setup the 5G NR private network.

SYLLABUS:

Experiment No.	Name of the Experiments
1.	**Set up a wired as well as wireless scenario to demonstrate the flow of operation (packets) using GUI based QualNet Network Simulator.**

2.	**Design and analyze an Ad hoc mode scenario as well an infrastructure mode scenario using GUI based QualNet Network Simulator.**
3.	**Configure an Adhoc mode wireless scenario and evaluate the effect of mobility to the data transferred using GUI Network Simulator.**
4.	**Configure an infrastructure mode wireless scenario and analyze the effect of mobility on throughput.**
5.	**Design an Adhoc mode wireless scenario and compare its performance based on two routing protocols (AODV and DYMO).**
6.	**Design an infrastructure mode wireless scenario and configure VOIP Application layer protocol based on H.323.**
7.	**Configure and evaluate a multicasting application in a wired and wireless scenario using GUI based QualNet Network Simulator.**
8.	**Configure and Interface Analog sensors using Scientech 2311 wireless sensor network setup to collect the sensed data.**
9.	**To develop a code to read temperature and light sensor data from sensor module attached to the radio module using SENSnuts GUI platform.**
10.	**Perform the convolutional encoding and hard decision Viterbi decoding for K = 7 and rate ½. Also compare the corresponding result with soft decision Viterbi decoding.**
11.	**Study and test the functioning of various applications using RFID system.**
12.	**Setup the 5G NR private network by configuring the core network and gNodeB to connect user equipment.**

List of Optional experiments:

1. Study the PN sequence and examine Gold Code with variable sequence length and analyse its correlation. Also perform the spreading of input binary data and corresponding de-spreading using DSSS scheme in CDMA trainer kit.
2. Set up a link between GPS satellite and GPS trainer kit, and measure the present position using GPS system. Also study the graphical representation of geographical position using Survey Plotting.
3. Configure ZigBee module as an end device and set up a communication link with two ZigBee modules.
4. Study the behaviour of AWGN samples captured from the Wi-Guy inbuilt SDR receiver.
5. Demonstrate the impact of the received power levels for hand-offs in case of mobile cellular communication using virtual lab for fading channels and mobile communications.
6. 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. Theidore 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): N/A

POs met through Gaps in the Syllabus: N/A

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

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 Outcome (CO) Attainment Assessment tools & Evaluation procedure :
Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	(60)
Attendance	12
Day-to-day performance	06
Lab Viva	20
Lab file	12
Lab Quiz-I	10
End SEM Evaluation	(40)
Lab Quiz-II	10
Lab Performance Test	30

Indirect Assessment

1. Student Feedback on Course

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**	**1**	**2**	**3**
CO1	3	0	1	1	2	0	0	0	0	1	1	3	2	2
CO2	3	3	2	1	2	2	0	0	0	1	1	3	2	2
CO3	3	3	2	1	2	2	1	0	0	1	1	3	2	2
CO4	3	3	2	1	2	2	0	1	0	1	1	3	2	2
CO5	3	2	2	2	2	2	2	1	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, CD3, CD5, CD9
CD2	Tutorials/Assignments	CO2	CD1, CD3, CD5, CD9
CD3	Seminars/ Quiz (s)	CO3	CD1, CD3, CD5, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD3, CD5, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD3, 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
Electronic Measurements

Course code: EC24361
Course title: Electronic Measurements
Pre-requisite(s): Basics Electronics
Co- requisite(s): N/A
Credits: L: 3 T: 0 P: 0 C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VI/03
Branch: ECE

Course Objectives

This course enables the students:

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

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	Demonstrate the process of balancing different bridge networks to find the value of unknown arm components.
CO3	Schematize the measurement of non-electrical parameters using different transducers.
CO4	Explain the working of different analog instruments (PMMC, Moving iron) and use them to design multi-range voltage, current and resistance measuring instruments.
CO5	Summarize the working of Digital instruments

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I 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.	**8**

Module – II Introduction of DC and AC Bridges: Wheatstone Bridge, Kelvin Double Bridge, Maxwell’s Bridge, and Hay’s Bridge, Anderson’s Bridge, Schering’s Bridge, Wien’s Bridge, Sources of errors in Bridges and their elimination by shielding and grounding, Q meter.	**8**
Module – III 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.	**8**
Module – IV Analogue Instruments: 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.	**8**
Module – V Digital Instruments**:** Sample-and-hold circuit, Digital Voltmeters, Digital Multimeters, Digital frequency Meter, Sampling oscilloscope, Storage CROs, Digital Storage Oscilloscopes	**8**

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): NA

POs met through Gaps in the Syllabus: NA

Topics beyond syllabus/Advanced topics/Design: NA

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

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

Direct Assessment

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

Indirect Assessment

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	1	2	3
CO1	3	3	2	3	3	1	0	0	3	0	3	3	2	1
CO2	3	3	2	3	3	3	0	0	3	0	3	3	2	1
CO3	3	3	2	3	3	3	0	0	3	0	3	3	2	1
CO4	3	3	2	3	3	2	0	0	3	0	3	3	2	1
CO5	3	3	2	3	3	2	0	0	3	0	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, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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

Measurement and Instrumentation Lab

Course code: EC24362
Course Title: Measurements and Instrumentation Lab
Pre-requisite(s): Basic Electronics, Digital System Design
Co-requisite(s): Electronic Measurements
Credits: L:0 T:0 P:2 C:1.0
Class schedule per week: 02
Class: B. Tech.
Semester / Level: VI/ 03
Branch: ECE

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, the 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 loops for industrial application.

Experiment No.	**Name of the Experiments**
	Physical parameter measurements
1.	**Measurement of temperature using RTD/ Thermocouple/ Thermistor**
2.	**Measurement of pressure using strain gauge.**
3.	**Measurement of torque using loadcell.**
	Measurement of motion

4.	**Displacement measurement using LVDT.**
5.	**Speed measurement using Photo-reflective and magnetic pickup.**
6.	**Vibration measurement using piezoelectric accelerometer.**
Pneumatic control	
7.	**Calibration of pressure instruments using dead weight pressure gauge tester.**
8.	**AND/ OR logic realization using Pneumatic trainer.**
Single loop control	
9.	**Flow measurement and control using orifice, U-tube Manometer and Rotameter.**
10.	**Level measurement and control using capacitive level sensors.**
Programmable Logic Control	
11.	**Logic gate simulation using PLC trainer module and lift control simulation using PLC trainer module.**
LabVIEW	
12.	**Logic gate simulation using LabVIEW and development of CRO and function generator using LabVIEW.**

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
Progressive Evaluation	**(60)**
Attendance	**12**
Day-to-day performance	**06**
Lab Viva	**20**
Lab file	**12**
Lab Quiz-I	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II	**10**
Lab Performance Test	**30**

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**	**1**	**2**	**3**
CO1	3	3	3	3	3	1	1	1	1	0	1	2	2	1
CO2	3	3	3	3	3	1	0	1	1	0	1	2	2	1
CO3	3	3	3	3	3	1	0	1	1	0	1	2	2	1
CO4	3	3	3	2	2	1	0	1	1	0	0	2	2	1
CO5	3	3	3	3	3	1	1	1	1	0	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, CD3, CD5, CD9
CD2	Tutorials/Assignments	CO2	CD1, CD3, CD5, CD9
CD3	Seminars	CO3	CD1, CD3, CD5, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD3, CD5, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD3, 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
Mobile and Cellular Communication

Course Code: EC24403
Course Title: Mobile and Cellular Communication
Pre-requisite(s): Analog and Digital Communication
Co- requisite(s): Microwave Engineering
Credits: L: 3 T: 0 P: 0 C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VII/ 04
Branch: ECE

Course Objectives

This course enables the students:

1	To understand the overview of cellular communication system, its generations and standards.
2	To evaluate the impact of interference on cellular communication.
3	To analyze effect of channel behavior on signal Propagation.
4	To understand different types of indoor and outdoor channel models.
5	To understand different types of channel impairments removal techniques.

Course Outcomes

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

CO1	Demonstrate an understanding of overview of cellular communication system, its generations and standards.
CO2	Architect, Interpret and select appropriate technologies for implementation of specified cellular communication systems.
CO3	Analyze and evaluate channel behavior to improve the system performance
CO4	Demonstrate an understanding of channel model for establishment of cellular system systems
CO5	Suggest and incorporate techniques to improve the performance of existing cellular system

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **The Cellular Fundamentals**: Wireless Communication Overview, Cellular Concept and Frequency Reuse, General Architecture of a Cellular System, Frequency Management and Channel Assignment, Handoff in a Cellular System.	7

Module – II **Cellular Systems and Standards**: Evolution of Mobile Cellular Communication: Different Generations (1G, 2G. 2.5G, 3G and 4G), Typical Cellular Standards (AMPS, GSM, GPRS, WCDMA, LTE advanced), 5G Features and Challenges, 6G Vision.	**9**
Module – III **Interference and Cellular System Capacity**: Co-channel Interference and Adjacent Channel Interference, Power Control, Enhancing Cellular System Capacity (Cell Splitting, Sectorization, Smart Antenna, Link Adaptation and Small Cell Deployment	**8**
Module – IV **Signal Propagation in Mobile Communication**: Mobile Cellular Environment, Multipath Propagation and Fading, Free Space Propagation Model, Outdoor and Indoor Propagation Models, Channel Parameters (Delay Spread, Doppler Spread, Coherence Bandwidth, Coherence Time, LCR and ADF)	**9**
Module – V **Channel Impairments Removal and Advanced Techniques:** Diversity Mechanisms and Combining Techniques (SC, TC, MRC, EGC), Equalization, Coding for Wireless Channels, OFDM, MIMO and Smart Antenna Technique	**7**

Textbook:

1. T. S. Rappaport, “Wireless Communications, Principles and Practice”, 2nd Edition, Pearson
2. Sanjay Kumar, “Wireless Communication the Fundamental and Advanced Concepts”, River Publishers, Denmark, 2015 (Indian reprint).

Reference Books:

1. Vijay K. Garg, “Wireless Communications and Networks”, Morgan Kaufmann Publishers an Imprint of Elsevier, USA 2009 (Indian reprint).
2. Simon Haykin and Michael Moher, “Modern Wireless Communications”, Parson Education, Delhi, 2005.
3. Theodore S Rappaport, “Wireless Communication: Principles and Practice” Prentice Hall of India, New Delhi, 2006, 2/e.

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
Assignment	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	1	2	3
CO1	3	2	2	1	1	1	1	2	2	1	2	3	2	2
CO2	3	3	2	3	2	1	1	2	2	1	1	3	2	2
CO3	3	3	2	3	2	1	1	2	2	1	1	1	2	3
CO4	3	3	2	3	3	1	1	2	2	1	1	3	2	1
CO5	3	3	2	3	3	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

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	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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
Satellite Communication

Course Code: EC24405
Course Title: Satellite Communication
Pre-requisite(s): Analog and Digital Communication,
Co- requisite(s): Microwave Engineering
Credits: L: 3 T: 0 P: 0 C:3
Class schedule per week: 03
B. Tech.
Semester / Level: VII/04
Branch: ECE

Course Objectives

This course enables the students:

1	To understand the satellite communication system
2	To evaluate the impact of interference on the satellite communication and complete link design.
3	To analyze different system parameters, causes of impairments in satellite communication system
4	To understand the multiple access techniques to support satellite communication and special satellite systems
5	An understand the working of 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 of 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 of satellite system, satellite sub system and earth station system.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **An overview of satellite communication:** 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, Station keeping	**10**
Module – II **Basic transmission theory:** Friss transmission equation, EIRP, Complete Link design, System noise temperature G/T ratio, Noise figure and Noise temperature.	**7**
Module – III **Communication Satellite Sub-systems:** 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	**7**
Module – IV **Multiple Access Techniques:** Multiple Access Techniques, FDMA Concept, MCPC & SCPC, TDMA frame efficiency and super frame structure, Frame Acquisition and Synchronization, CDMA concept, PN system, Spread spectrum, DSSS, DS CDMA, FHSS, FH CDMA. Demand Assignment Multiple Access, Digital Speech Interpolation and SPADE.	**10**
Module – V **Special Purpose Satellite:** INTELSAT, INMARSAT, Direct Broadcast Satellite, Very Small Aperture Terminal Networks, Mobile Satellite Networks and Global Positioning Satellite system	**6**

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
Assignment/ Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.
2.

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**	**1**	**2**	**3**
CO1	3	1	1	2	1	0	0	0	0	0	2	3	2	1
CO2	3	3	3	2	1	0	0	0	0	0	1	3	2	2
CO3	3	3	2	2	2	0	0	0	0	0	1	3	2	1
CO4	3	2	1	1	1	0	0	0	0	0	1	3	2	3
CO5	3	1	1	2	1	0	0	0	0	0	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, CD2, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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

Industrial Instrumentation

Course code: EC24407
Course title: Industrial Instrumentation
Pre-requisite(s): Electronic Measurements
Co- requisite(s): N/A
Credits: L: 3 T: 0 P: 0 C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VII/04
Branch: ECE

Course Objectives

This course enables the students:

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 analyze 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)
Module – I Review of Transducers: Principles of operations and its classification, Characteristics, Technological trends in making transducers, Silicon sensors for the measurement of pressure, Level, Flow and Temperature, Biosensors, types and its Application. Radiation Sensors, X -ray and nuclear radiation sensors, Fiber optic sensors for Temperature, Liquid level, Fluid- flow measurement.	**8**
Module – II Components of Industrial Automation system: Detailed study of each block involved in making DAS, Signal Conditioners: as DA, IA, Signal Converters	**8**

(ADC & DAC), Sample and hold, Designing of Pressure, Temperature measuring instrumentation system using DAS, Data logger. I to P converter. Actuators: Pneumatic cylinder, Relay, Solenoid (Final Control Element).	
Module – III Control Systems: Concepts of Controllers Schemes, Types of Controllers, Computer Supervisory Control System (SCADA), Direct Digital Control's Structure and Software, Introduction to Distributed Digital Control.	**8**
Module – IV Programmable Logic Controllers: Introduction of Programmable logic controller, Principles of operation, Architecture of Programmable controllers, Programming the Programmable controller.	**8**
Module – V Intelligent Controllers: Introduction to Intelligent Controllers, Model based controllers, Predictive control, Artificial Intelligent Based Systems, Experts Controller, Introduction to Fuzzy Logic System and Controller, Artificial Neural Networks, Neuro-Fuzzy Controller system.	**8**

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): NA

POs met through Gaps in the Syllabus: NA

Topics beyond syllabus/Advanced topics/Design: NA

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

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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**	**1**	**2**	**3**
CO1	3	3	2	3	3	1	0	0	3	0	3	3	3	1
CO2	3	3	2	3	3	3	0	0	3	0	3	3	3	1
CO3	3	3	2	3	3	3	0	0	3	0	3	3	3	1
CO4	3	3	2	3	3	2	0	0	3	0	3	3	3	1
CO5	3	3	2	3	3	2	0	0	3	0	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, 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
Optimization Techniques

Course code: EC24409
Course title: Optimization Techniques
Pre-requisite(s): Probability and Random Processes
Co- requisite(s): N/A
Credits: L: 3 T: 0 P: 0 C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VII/04
Branch: ECE

Course Objectives

This course enables the students:

1.	Gain understanding on optimization theory and its elements
2.	Demonstrate single variable optimization, linear programming, dynamic programming concepts and techniques.
3.	Demonstrate multivariable and constraint optimization concepts and techniques.
4.	Understand advanced single and multi-objective optimization techniques such as GA, PSO, Pareto font, NSGA
5.	Demonstrate an ability to apply the optimization techniques to various areas of Engineering and Science.

Course Outcomes

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

CO1	Understand how to formulate an optimization problem and its characteristics.
CO2	Have an ability to analyse and apply algorithms for design optimization.
CO3	Have an ability to find optimum solution by applying the single and multi-objective evolutionary techniques.
CO4	Develop an ability to apply use optimization techniques to finance, economics, medical applications, control, communication, power, mechanical problems, chemical and biology.
CO5	Aspire to pursue a career in Optimization, recognize the need to learn and adapt to the change in technology and play role of team leader.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Optimal problem formulation, Design variables constraints, Objective function, Variable bounds, Search methods: optimality Criteria, Bracketing methods: Exhaustive search methods, Region – Elimination methods; Interval halving	**8**

method, Fibonacci search method, Golden section search method, Point-estimation method; Successive quadratic estimation method.	
Module – II Gradient-based methods: Newton-Raphson method, Bisection method, Secant method, Cauchy's steepest descent and Newton's method. Linear Programming: Graphical method, Simplex Method, Revised simplex method, Duality in Linear Programming (LP), integer linear programming, Dynamic programming, Sensitivity analysis.	**8**
Module – III Optimality criteria, Unidirectional search, Direct search methods: Simplex search method, Hooke-Jeeves pattern search method. Gradient based method, conjugate gradient method, concept of Lagrangian multiplier, complex search method, characteristics of a constrained problem. Direct methods: The complex method, Cutting plane method, Indirect method: Transformation Technique, Basic approach in the penalty function method, Interior penalty function method, convex method.	**8**
Module – IV Genetic algorithm and its working principle, GA variants, Particle swarm optimization and its working principle, Differential evolution, Ant Colony Optimization, Applications in Engineering problems.	**8**
Module – V Multi objective Optimization problem, Dominance and Pareto-Optimality, Pareto font, Multi- objective Evolutionary Algorithms, Multi Objective genetic Algorithm, NSGA, Constrained Multi-objective Evolutionary Algorithms, Application to communication, medical, clustering, bioinformatics, control, finance.	**8**

Textbooks:

1. Optimization for Engineering Design - Kalyanmoy Deb, 2006, PHI
2. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, Wiley India publisher, 2010
3. S.S. Rao, Engineering Optimization, Theory and practice, New age International Publisher, 2012
4. D.E. Goldberg, genetic Algorithm in search, optimization and machine learning, Addison-Wesley Longman Publisher, 1989

Reference books:

1. Analytical Decision Making in Engineering Design - Siddal.
2. G. Hadley, "Linear programming", Narosa Publishing House, New Delhi, 1990.

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

POs met through Gaps in the Syllabus: NA

Topics beyond syllabus/Advanced topics/Design: NA

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

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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**	**1**	**2**	**3**
CO1	3	2	1	2	2	2	2	0	0	2	3	2	2	2
CO2	3	3	2	2	2	1	1	0	0	2	3	2	2	2
CO3	3	3	3	3	3	3	1	0	0	2	3	2	2	2
CO4	3	3	3	3	3	3	1	0	0	2	3	2	2	2
CO5	3	3	3	3	3	3	1	0	0	2	3	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	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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

Internet of Things

Course code: EC24411
Course title: Internet of Things
Pre-requisite(s): Data Communication and Computer Networking
Co- requisite(s): N/A
Credits: L: 3 T: 0 P: 0 C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VII/04
Branch: ECE

Course Objectives

This course enables the students:

1.	To understand Internet of Things concepts, and IoT enabled technologies.
2.	To comprehend hardware and software components of IoT.
3.	To understand solution framework for IoT applications.
4.	To comprehend different security protocols in IoT.
5.	To learn about implementation of different case studies/mini projects.

Course Outcomes

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

CO1	Comprehend Internet of Things concepts, and IoT enabled technologies.
CO2	Able to Implement hardware and software components of IoT.
CO3	Design solution framework for IoT applications.
CO4	Comprehend security protocols in different IoT applications.
CO5	Able to Implement mini projects and different case studies.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction to IoT** Introduction to Internet of Things- Definition and Characteristics of IoT, Sensors, Actuators, Physical Design of IoT: IoT Protocols, IoT communication models, IoT Communication APIs, IoT enabled Technologies: Wireless Sensor Networks, Cloud Computing, Embedded Systems, IoT Levels and Templates, M2M and IoT Technology & Analytics.	**8**

Module – II **Elements of IoT** Hardware Components: Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components: Programming API's (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.	**8**
Module – III **IoT Application Development** Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage: Unstructured data storage on cloud/local server, Authentication, authorization of devices.	**8**
Module – IV **Security in IoT protocols** Application Layer, Data and Analytics for IoT, IoT Middleware, Data analytics for IoT, Big Data analytics tools and technology.	**8**
Module – V **IoT Case Studies** IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation.	**8**

Textbooks:

1. "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", D. Hanes, G. Salgueiro, P. Grossetete, R. Barton, J. Henry,1st edition, Pearson India Pvt. Ltd.
2. "Internet of Things: Architecture and Design", Raj Kamal, McGraw Hill

Reference books:

1. "Introduction to Internet of Things: A practical Approach, Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, ETI Labs
2. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases'', Pethuru Raj and Anupama C. Raman, CRC Press.
3. "Internet of Things", Jeeva Jose, Khanna Publishing House, Delhi

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 and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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	1	2	3
CO1	3	3	2	2	3	1	0	0	1	1	1	3	3	2
CO2	3	3	2	2	3	1	0	0	1	1	1	3	3	2
CO3	3	3	2	2	3	1	0	0	1	1	1	3	3	2
CO4	3	3	2	2	3	1	0	0	1	1	1	3	3	2
CO5	3	3	2	2	3	1	0	0	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

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	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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
Low Power VLSI Circuits

Course code: EC24413
Course Title: Low Power VLSI Circuits
Pre-requisite(s): Basic Electronics, Electronic Devices
Co-requisite(s): NA
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: V/03
Branch: ECE

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, and system level and apply the perceived knowledge.
C.	Appraise and analyze the power optimization techniques @ design time for memory circuits.
D.	Appraise and evaluate power optimization techniques @ Standby for memory, circuits, and systems.
E.	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 the nanometre transistor models, power, and energy basics.
CO2	Explain the power optimization techniques at design time at the circuit level.
CO3	Apply the power optimization techniques at design time for memory circuits.
CO4	Apply and analyze power optimization techniques at standby for memory, circuits, and systems.
CO5	Design low-power/low-voltage digital, memory, and analog circuits for solving day-to-day life problems.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Nanometer Transistor Models, Power and Energy Basics:** Nanometer transistor behavior and models, velocity saturation model, alpha power model, leakage currents in a nanometer MOSFET, variability, sources of variability, Digital design metrics – power, delay, energy metrics, dynamic power, short-circuit power, static power, sources of static power dissipation.	**8**

Module – II **Optimizing Power at Design Time: Circuit Level Techniques:** Optimization framework for energy-delay trade-off, dynamic-power optimization, multiple supply voltages, transistor sizing, static-power optimization, multiple thresholds, Transistor stacking, Adiabatic logic.	**8**
Module – III **Optimizing Power at Design Time: Memory:** Role of memory in ICs, Cache Memory Architectures, SRAM Metrics, Power breakdowns of SRAM, Power-saving techniques for SRAM, 6T SRAM Cell.	**8**
Module – IV **Optimizing Power at Standby: Memory, Circuits, and Systems:** Optimizing SRAM 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.	**8**
Module – V **Design of Low-Power/Low-Voltage Analog Circuits in Weak Inversion** Minimum Saturation Voltage, Cascode mirror in weak or moderate inversion, low-voltage amplifiers: CMOS inverter-amplifier, Maximum Transconductance-to-Current Ratio: Differential Pair, Single-Stage Operational Transconductance Amplifiers (OTA).	**8**

Textbooks:

1. Jan M. Rabaey, "Low power essentials", First Edition, Springer, 2009, ISBN 978-0-387-71712-8.
2. 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): NA

POs met through Gaps in the Syllabus: 10

Topics beyond syllabus/Advanced topics/Design: NA

POs met through Topics beyond syllabus/Advanced topics/Design: 10

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

Direct Assessment

Exam		Marks	Total Marks
Internal Evaluation	A. First Quiz	10	50
	B. Mid Semester Examination	25	
	C. Assignment	10	
	D. Teacher's Assessment	5	
End Semester Examination		50	50
		Total	100

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**	**1**	**2**	**3**
CO1	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO2	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO3	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO4	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO5	3	3	1	2	3	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, CD4, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD4, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD4, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD4, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2, CD3, CD4, 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
Speech and Audio Processing

Course Code: EC24415
Course Title: Speech and Audio Processing
Pre-requisite(s): Digital Signal Processing, Probability and Random Processes
Co**- requisite(s):**
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech
Semester / Level: 04
Branch: ECE

Course Objectives

This course envisions to impart students to:

1	To understand the basics of speech production, the human auditory model, and the speech coding techniques.
2	To understand different speech signal processing techniques.
3	To understand the basics of scalar and vector quantization.
4	To understand the basics of speech enhancement.
5	To understand automatic speech recognition (ASR).

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 signals for its enhancement
CO3	Analyze the quality and properties of the speech signal
CO4	Modify and enhance 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)
Module – I **Speech production and modeling**: Human auditory system, Articulatory phonetics - Production and classification of speech sounds, Acoustic phonetics - acoustics of speech production, General structure of speech coders, Classification of speech coding techniques – parametric, waveform and hybrid, Requirements of speech codecs – quality, coding delays, robustness.	**8**
Module – II **Speech Signal Processing:** Pitch detection; Formant estimation; Short-term processing of speech; time, frequency, and time-frequency analysis, Short-term Fourier transform (STFT), Mel-frequency cepstral coefficient (MFCC), Delta and Delta-delta MFCC, Linear prediction (LP) analysis.	**8**
Module – III **Speech Quantization:** Scalar quantization–uniform quantizer, Optimum quantizer, logarithmic quantizer, adaptive quantizer, differential quantizers; Vector quantization – distortion measures, codebook design, codebook types.	**8**
Module – IV **Speech Enhancement:** Objectives, Issues, Enhancement of noisy speech, Reverberant speech, and multi-speaker speech using time, frequency, and time-frequency approaches.	**8**
Module – IV **Automatic Speech Recognition (ASR):** Description of ASR, Speech recognition using Vector quantization (VQ), Gaussian mixer model (GMM), Hidden Markov model (HMM), and Neural networks (NN).	**8**

Text Books:

1. L.R. Rabiner, B. H. Juang and B. Yegnanarayana, “Fundamentals of Speech Recognition”, Pearson, Education 2011.
2. L. R. Rabiner and R. W. Schafer, “Digital Processing of Speech Signals”, Pearson Education, India, 2004.

Reference Books:

1. W. C. Chu, “Speech Coding Algorithms: Foundation and Evolution of Standardized Coders”, Wiley Inter science, 2003.
2. A. M. Kondoz, “Digital Speech”, Second Edition (Wiley Students Edition), 2004.

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

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

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

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes into Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	3	2	2	2	1	0	0	2	3	3	1	2	2
CO2	3	3	3	3	3	2	0	0	2	3	3	1	2	3
CO3	3	3	3	3	3	1	0	2	3	3	3	2	3	3
CO4	3	3	2	3	3	2	1	2	3	3	3	2	2	3
CO5	3	2	1	1	2	1	0	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, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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

FPGA Systems

Course code: EC24417
Course Title: FPGA Systems
Pre-requisite(s): Basic Electronics, Electronic Devices
Co-requisite(s): NA
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VII/04
Branch: ECE

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	Apply ethical principles while implementing strategies for FPGA- based digital integrated circuits.
CO2	Apply programmable Devices and switch technologies for professional engineering solutions and sustainable development for the society.
CO3	Design arithmetic building blocks and memory elements for solving complex engineering problems.
CO4	Analyze FPGA- based system applying EDA tools like Xilinx ISE to solve practical problems
CO5	Solve day-to-day life problem by testing digital and memory circuits and systems.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Implementation strategies for digital ICs:** From Custom to Semicustom and Structured Array Design Approaches, Custom Circuit Design, Cell-Based Design Methodology, Array-Based Implementation Approaches, Design examples of combinational circuits using Verilog/SystemVerilog HDL and FPGA-implementation.	**8**

Module – II **Programmable Devices and Programmable switch technologies:** Evolution of PLDs, CPLD versus FPGA, Internal structure of CPLD and FPGA, Programmable switch technologies, Applications of FPGAs, Xilinx FPGA Structure, Memory cells in FPGA switch matrix, simplified Xilinx CLB, Xilinx IOB Structure, CLB configuration to implement Boolean function. Design examples of clock and test bench using Verilog/SystemVerilog HDL and FPGA-implementation.	**8**
Module – III **Designing arithmetic building blocks:** Full Adder Circuit Design Considerations, Multiplier Design Considerations; Power and Speed Trade-off's in Datapath Structures: Design Time Power-Reduction Techniques, Run-Time Power Management, Reducing the Power in Standby (or Sleep) Mode, Design examples of Datapath using Verilog/ SystemVerilog HDL and FPGA-implementation.	**8**
Module – IV **Designing memory and array structures:** 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, Drivers/Buffers, Voltage References. Design examples of memory circuits using Verilog, SystemVerilog HDL and FPGA-implementation.	**8**
Module – V **Validation and test of manufactured circuits:** Boundary-Scan Design, Built-in Self-Test (BIST), Test-Pattern Generation, Fault Models: Stuck-At Faults, Short-Circuit and Open-Circuit Faults, Fault Coverage, Delay Fault Testing, Automatic Test-Pattern Generation (ATPG), *FPGA-assisted testing*.	**8**

Textbooks:

1. J. Rabaey, A. Chandrakasan, B. Nikolic, "Digital Integrated Circuits: A Design Perspective", 2/e, 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.
3. Stephen Brown and Zvonko Vranesic, "Fundamentals of Digital Logic with VHDL Design 2/e, McGraw-Hill, 2005.

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): Hands-on-practical for IC fabrication.

POs met through Gaps in the Syllabus: 10

Topics beyond syllabus/Advanced topics/Design: NA.

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

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Exam	**Components**	Marks	Total Marks
Internal Evaluation	A. First Quiz	10	50
	B. Mid Semester Examination	25	
	C. Assignment	10	
	D. Teacher's Assessment	5	
End Semester Examination		50	50
		Total	100

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**	**1**	**2**	**3**
CO1	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO2	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO3	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO4	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO5	3	3	1	2	3	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	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD4, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD4, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD4, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2, CD3, CD4, 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
Antennas and Wave Propagation

Course code: EC24419
Course title: Antennas and Wave Propagation
Pre-requisite(s): Electromagnetic Theory, Network Theory
Co- requisite(s): Electromagnetic Theory
Credits: L: 3 T: 0 P: 0 C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VII/ 04
Branch: ECE

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 its 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 able to:

CO1	Comprehend the basic concept of antenna, antenna parameters and radio wave propagation.
CO2	Design and analyse the various antenna arrays.
CO3	Design and characterize the special antennas used in communication and their applications.
CO4	Apply the knowledge on the measurements of Antenna parameters with measurement components.
CO5	Analyse the propagation characteristics of radio waves.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module– I **Antenna Fundamentals** : Radiation Principles, Hertzian dipole, Half Wave Dipole and Monopole Antenna, Slot Antennas, Reciprocity Principle. **Antenna Parameters:** Radiation Patterns, Beam Width, Directivity and Gain, Bandwidth, Polarization, Input Impedance, Efficiency, Effective Length / Area, Antenna Temperature.	**12**

Module– II **Antenna Arrays:** Uniform Linear Array - Two element array, N-element linear array -Broadside array, Endfire Array, Pattern Multiplication, Binomial Array, Chebyshev Array	**8**
Module– III **Special Antennas:** Loop Antennas, Travelling Wave Antennas, Broadband Antennas: Helical, Frequency Independent Antennas: Log Periodic, Spiral Antenna. Reflector, Yagi- Uda, Microstrip Antennas.	**8**
Module– IV **Antenna Measurements:** Measurement Components and Instruments, Measurement Parameters: Antenna impedance, Pattern measurements, Measurement of Antenna Gain, Beam width, Radiation resistance, Antenna efficiency, Directivity.	**6**
Module– V **Propagation of radio waves**: Propagation and general characteristics of radio waves- Ground Wave, Space Wave, Sky Wave.	**6**

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, 1st edition 2007, ISBN - 13: 978 -0- 19 - 568666-1, ISBN - 10: 0 - 19 - 568666 - 7.

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

Hands on experience on real-time industrial projects and management.

POs met through Gaps in the Syllabus: PO11

Topics beyond syllabus/Advanced topics/Design:

Design and development of low profile microstrip antennas for 5G and millimetre wave applications.

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

Assignments, Seminars and Project.

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

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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**	**1**	**2**	**3**
CO1	3	3	1	2	1	0	0	0	1	1	2	3	2	1
CO2	3	3	3	3	2	1	0	0	1	1	2	3	2	2
CO3	3	3	3	3	3	1	0	2	1	2	3	3	3	3
CO4	3	2	3	3	3	1	1	3	2	2	2	3	2	2
CO5	3	2	2	3	2	1	0	1	2	1	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, 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
Microelectronic Devices and Circuits

Course code: EC24421
Course title: Microelectronic Devices and Circuits
Pre-requisite(s): Basic Electronics, 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

Course Objectives

This course enables the students to:

1.	Understand the Physics of Modern Devices.
2.	Grasp the characteristics modern MOS Devices and apply the obtained knowledge.
3.	Appraise and analyse the CMOS Performance Factors.
4.	Evaluate the characteristics of Current Mirrors, Single- and -two Stage OTA.
5.	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 the Physics of Modern Devices.
CO2	Explain the modern MOS Devices, CMOS Performance Factors.
CO3	Analyse MOS Devices and CMOS Performance Factors
CO4	Design Current Mirror, Single- and -two Stage OTA for solve day-to-day life problems.
CO5	Appraise the Manufacturing steps and Layout structures of CMOS Integrated Circuits.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I **Basic Device Physics:** Modern CMOS Transistors: CMOS processes, CMOS process enhancements, **Metal-Silicon Contacts, High-Field Effects:** 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	**8**
Module – II	**8**

MOS Devices: 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.	
Module – III **CMOS Performance Factors:** 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.	**8**
Module – IV **Current Mirrors, Single- and -two Stage OTA:** 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.	**8**
Module – V **Manufacturing steps and Layout of CMOS Integrated Circuits:** **CMOS IC fabrication Steps**: Silicon Wafer, Diffusion, ion-implantation, annealing, etching, patterning or lithography, oxidation, sputtering, deposition, metallization, planarization; **Layout**: Design Rules, Layouts of Universal Gates & complex logic gates; Variability and Mismatch; **Analog Layout Considerations:** Analog design issues**,** common-centroid layout, capacitor & resistor layout and matching.	**8**

Textbooks:

1. Neil H. E. Weste and Kamran Eshranghian, “Principles of CMOS VLSI Design: A Systems Perspective”, 2nd ed., Addition-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”, 4th 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): Hands-on-practical for Device/IC fabrication.

POs met through Gaps in the Syllabus: 10
Topics beyond syllabus/Advanced topics/Design: CNFET, TFET, MTJ, Memristor, SET, RTD.

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

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Exam	**Components**	Marks	Total Marks
Internal Evaluation	A. First Quiz	10	50
	B. Mid Semester Examination	25	
	C. Assignment	10	
	D. Teacher's Assessment	5	
End Semester Examination		50	50
		Total	100

Indirect Assessment

1. Student Feedback on Faculty
2. 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**	**1**	**2**	**3**
CO1	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO2	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO3	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO4	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO5	3	3	1	2	3	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	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD4, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD4, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD4, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2, CD3, CD4, 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
Nanoelectronics

Course code: EC24423
Course Title: Nanoelectronics
Pre-requisite(s): Basic Electronics, Electronic Devices
Co-requisite(s): NA
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VII/04
Branch: ECE

Course Objectives

This course enables the students to:

1.	Understand the theory advanced electronic devices like FinFET, TFET, MTJ, Memristor, RTD, Nanowire FET, CNTFET.
2.	Explain Crystalline Electronic Materials.
3.	Appraise and analyze 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 solving day-to-day life problems.

Course Outcomes

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

CO1	Describe advanced electronic devices like FinFET, TFET, MTJ, Memristor, RTD, Nanowire FET, CNTFET.
CO2	Explain Crystalline Materials and Its Applications.
CO3	Analyze Single-Electron Transistor.
CO4	Apply the knowledge of Quantum Wells, Quantum Wires, and Quantum Dots.
CO5	Design advanced device-based circuit for solving day-to-day life problems.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction to Advanced Devices:** Introduction to nanoelectronics, Quantum Mechanics and its application, Introduction to FinFET, TFET, MTJ, Memristor, RTD, Nanowire FET, CNTFET.	**8**

Module – II **Crystalline Materials and Its Applications:** Crystalline Materials, Graphene and Carbon Nanotubes, Tunneling Through a potential Barrier, Potential Energy Profiles for Material Interfaces, Applications of Tunnelling.	**8**
Module – III **Coulomb Blockade and the Single-Electron Transistor:** Coulomb Blockade, The Single-Electron Transistor (SET), SET logic; Carbon Nanotube FET and SET structures, Semiconductor Nanowire FETs, Molecular SETs.	**8**
Module – IV **Models of Semiconductor Quantum Wells, Quantum Wires and Quantum Dots:** Semiconductor Heterostructures and Quantum Wells, Quantum Wires and Nanowires; Quantum Dots and Nanoparticles, Fabrication Techniques for Nanostructures.	**8**
Module – V **Nanowires, Ballistic Transport and Spin Transport**: Classical and Semiclassical Transport, Ballistic Transport, Transport of Spin, Spintronic Devices and Applications.	**8**

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): NA

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

Exam		Marks	Total Marks
Internal Evaluation	A. First Quiz	10	50
	B. Mid Semester Examination	25	
	C. Assignment	10	
	D. Teacher's Assessment	5	
End Semester Examination		50	50
		Total	100

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**	**1**	**2**	**3**
CO1	3	3	1	3	3	1	1	1	3	1	3	3	2	1
CO2	3	3	2	3	3	3	1	1	3	1	3	3	2	1
CO3	3	3	1	3	3	3	1	1	3	1	3	3	2	1
CO4	3	3	1	3	3	1	1	1	3	1	3	3	2	1
CO5	3	3	2	3	3	3	1	1	3	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	CO1	CD1, CD2, CD3, CD4, CD 8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD4, CD 8
CD3	Seminars	CO3	CD1, CD2, CD3, CD4, CD 8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD4, CD 8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2, CD3, CD4, CD 8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as the use of NPTEL Materials and Internet		
CD9	Simulation		

COURSE INFORMATION SHEET
MEMS and Microsystems

Course code: EC24425
Course title: MEMS and Microsystems
Pre-requisite(s): Electronic Measurements, VLSI Design
Co- requisite(s): N/A
Credits: L: 3 T: 0 P: 0 C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VII/04
Branch: ECE

Course Objectives

This course enables the students:

1.	To understand the need of miniaturization, MEMS and microsystems
2.	To classify different microfabrication techniques suitable to application
3.	To acquire basic knowledge about application of MEMS in different areas
4.	To understand different electronic circuits and control for MEMS and packaging of MEMS devices
5.	To understand finite element modeling method with help of case studies

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)
Module – I Miniaturization, Microsystems and MEMS, Role of Microfabrication, Integrated Microsystems, micromechanical structures, microsensors, microactuators, Scaling in Mechanical Domain, Electrostatic Domain, Magnetic Domain, Thermal Domain	**8**

Module – II Thin Film Deposition – Evaporation, Sputtering, Chemical Vapor Deposition, Thermal Oxidation, Photolithography, Etching – Isotropic Etching, Anisotropic Etching, Dry etching, Bulk Micromachining, Surface Micromachining, LIGA.	**8**
Module – III Microsystems – Silicon capacitive Accelerometer, Piezoresistive Pressure Sensor, Gas Sensor, Electrostatic Comb Drive, Piezoelectric Inkjet Printhead, microsystems packaging, types and issues in packaging, reliability and key failure mechanisms.	**8**
Module – IV **Electronics Circuits and Control for MEMS:** Operational amplifier, basic op-amp circuits, Difference Amplifier, Instrumentation Amplifier, Wheatstone's bridge for change in resistance measurement, phase locked loop, Analog to digital converter.	**8**
Module – V **Modelling and Finite Element method:** Geometry and materials, meshing a model, simulation model, analysis and verification, case studies with FEM software – Analysis of piezoelectric Bimorph cantilever beam /piezoelectric actuators / piezoresistive sensors.	**8**

Books recommended:

Textbooks:

1. Micro and Smart Systems, G.K. Anantha Suresh, K.J Vinoy, S. Gopalakrishnan, K.N. Bhat, V. K. Aatre Wiley, India, ISBN978-81-265-2715-1
2. Foundations of MEMS by Chang Liu, Second Edition, Pearson, ISBN 978-81-317-6475-6

Reference Book:

1. Marc Madou, Fundamentals of Microfabrication by, CRC Press, 1997.
2. Gregory Kovacs, Micromachined Transducers Sourcebook WCB McGraw-Hill, Boston, 1998.
3. M.-H. Bao, Micromechanical Transducers: Pressure sensors, accelerometers, and gyroscopes by Elsevier, New York, 2000.

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

POs met through Gaps in the Syllabus: NA

Topics beyond syllabus/Advanced topics/Design: NA

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

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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**	**1**	**2**	**3**
CO1	3	3	3	1	0	0	0	2	2	0	0	3	1	1
CO2	3	3	3	3	2	0	0	2	3	1	0	3	1	1
CO3	0	3	3	1	3	0	0	2	3	0	0	3	2	1
CO4	3	3	3	1	0	0	0	0	0	0	2	3	2	1
CO5	3	1	0	0	1	0	0	1	0	1	0	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, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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

Radar Engineering

Course code : EC24427
Course title : Radar Engineering
Pre-requisite(s): Electromagnetic Fields and Waves, Signals and Systems
Co- requisite(s): NIL
Credits: L: 3 T: 0 P: 0 C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VII/IV
Branch: ECE

Course Objectives

This course enables the students:

1.	An understanding on Radar Engineering and its applications
2.	An understanding of MTI and pulse Doppler Radar
3.	An ability to analyze different RADAR clutters
4.	An understanding of object Tracking by RADAR
5.	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

MODULE	(NO. OF LECTURE HOURS)
Module – I **INTRODUCTION TO RADAR** 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.	**10**

Module – II **MTI AND PULSE DOPPLER RADAR** Introduction to Doppler and MTI Radar, Delay line Cancellers, Digital MTI processing, Moving target Detector, Pulse Doppler Radar, Non-Coherent MTI.	**7**
Module – III **TRACKING RADAR** Tracking with Radar, Mono-pulse tracking, Conical Scan and sequential lobbing, tracking in Range.	**7**
Module – IV **RADAR CLUTTER** Introduction to Radar Clutter, Surface Clutter radar equation, Land Clutter, Sea Clutter.	**10**
Module – V **RADAR RECEIVER** 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.	**6**

Textbooks:

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 and Evaluation Procedure:

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	10
Teacher’s Assessment	15
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Faculty

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**	**1**	**2**	**3**
CO1	3	1	1	2	1	0	0	0	0	0	2	3	2	1
CO2	3	3	3	2	1	0	0	0	0	0	1	3	2	2
CO3	3	3	2	2	2	0	0	0	0	0	1	3	2	1
CO4	3	2	1	1	1	0	0	0	0	0	1	3	2	3
CO5	3	1	1	2	1	0	0	0	0	0	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
Wireless Sensors Network

Course code: EC24429
Course title: Wireless Sensors Network
Pre-requisite(s): Communication and Networking
Co- requisite(s): Nil
Credits: L:3 T:0 P:0 C: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: I/05
Branch: ECE

Course Objectives:

This course aims to develop:

1	An understanding of the concept of wireless adhoc and wireless sensor network with its major challenges.
2	An understanding of WSN architecture and its design principles.
3	Fundamental understanding on MAC, routing and transport protocols.
4	An ability to evaluate Localization and Positioning techniques in wireless adhoc and wireless sensor network.
5	An ability to design and provide solutions for practical low cost, energy efficient, and reliable wireless sensor network.

Course Outcomes:

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

CO1	Have an ability to explain wireless adhoc & sensor network and its various components.
CO2	Have an ability to demonstrate several architectures of WSN and provide a new design solution according to the required applications.
CO3	Have an ability to design several MAC, Routing and transport protocols for WSNs.
CO4	Demonstrate several Localization & Positioning techniques in wireless adhoc & sensor network.
CO5	Have an ability to provide practical solutions and apply the subject expertise for the welfare of society.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I **INTRODUCTION TO WIRELESS SENSOR NETWORKS** Fundamentals of Wireless Networks, Radio propagation Mechanisms, Characteristics of the wireless channel, mobile ad hoc networks (MANETs), wireless sensor networks (WSNs): Basic concept, Design Challenges and Applications.	**9**

Module – II **SINGLE NODE AND NETWORK ARCHITECTURE** Single node architecture: hardware and software components of a sensor node, Network Architecture: 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.	**8**
Module – III **MAC PROTOCOLS** Fundamental of MAC protocols and its classification, Issues in designing MAC protocols, 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.	**8**
Module – IV **ROUTING AND TRANSPORT CONTROLS PROTOCOL** Routing challenges in WSNs, routing protocols, energy efficient unicast routing, energy efficient broadcast /multicast routing, Geographical routing, traditional and recent transport control protocols.	**8**
Module – V **LOCALIZATION AND POSITIONING:** 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.	**8**

Text books:

1. Kazem Sohraby, Daniel Minoli, Taieb Znati, “Wireless Sensor Networks’, John Wiley & Sons Inc. Publication.
2. Holger Karl, and Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks” John Wiley & Sons Inc. Publication.

Reference books:

1. XiangYang Li, “Wireless Adhoc and Sensor Networks: Theory and Applications”, Cambridge university press, USA, 2008.

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

Applications of digital image 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

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	10
Teacher's Assessment	05
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes into Program Outcomes

Course Outcome	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	1	0	0	0	1	0	0	0	0	1	3	2	1
CO2	3	2	1	2	0	1	0	0	0	0	1	3	2	2
CO3	3	3	1	2	1	1	0	0	0	0	1	3	2	1
CO4	3	3	1	2	1	1	1	0	0	0	1	3	2	3
CO5	3	2	3	3	1	1	1	2	0	0	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, 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
Digital Image Processing

Course code: EC24431
Course title: Digital Image Processing
Pre-requisite(s): Digital Signal Processing
Co- requisite(s): N/A
Credits: L: 3 T: 0 P: 0 C:3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VII/04
Branch: ECE

Course Objectives:

This course enables the students:

1.	To gain understanding on digital image formation, characteristics, and its pixel based processing.
2.	To demonstrate the use of different spatial and frequency domain techniques to enhance images.
3.	To be able to understand image restoration.
4.	To apply various compression techniques to images.
5.	To understand various image description and representation methods for computer vision applications.

Course Outcomes:

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

CO1	Develop an understanding on the image formation, pixel characteristics and pixel based image processing.
CO2	Enhance the image using transformed and spatial domain filters.
CO3	Develop an ability to restore images corrupted by noise and motion blur.
CO4	Develop different techniques to compress images.
CO5	Segment and represent the image for computer vision tasks.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Fundamental steps in Digital Image Processing, Components of an Image processing system, Digital Image Representation, Basic relationship between pixels, Basic Arithmetic/Logic operations on image, Geometric transformations, Image interpolation, Color Images and Pseudocolor image processing.	**8**

Module – II Gray Level Transformations, Histogram Processing, Convolution and Correlation Operations, Smoothing and Sharpening with Spatial Domain filters, Fourier Transform, Fast Fourier Transform, Smoothing and Sharpening with Frequency Domain filters, Homomorphic filtering.	**8**
Module – III Introduction to Image Restoration, Noise Models, Degradation functions, Inverse filtering, Weiner filtering, Constrained Least Squares filtering, Geometric mean filter, Hough transform, Image reconstruction from projections.	**8**
Module – IV Fundamentals of image compression, Redundancy, Image Compression Models, Coding Theorems: Huffman Coding, Golomb Coding, Arithmetic Coding, LZW Coding, Run-length Coding and Bitplane coding, Error-free Compression techniques: Variable- length Coding and Lossless Predictive Coding, Lossy Compression techniques: Lossy Predictive Coding and Wavelet Coding, Image Compression Standards.	**8**
Module – V Morphological Image processing: Erosion, Dilation, Opening and Closing; Introduction to Image segmentation, Optimal Global and Adaptive thresholding, Region-based Segmentation, Image Feature descriptors: GLCM, Chain codes, Regional and boundary descriptors, Scale invariant feature transform (SIFT), Image Feature classification: Bayes classifier, Random Forest classifier.	**8**

Textbooks:

1. "Digital Image Processing", Rafael C. Gonzalez and Richard E. Woods, 4e, Pearson Education.
2. "Image Processing, Analysis and Machine Vision", Milan Sonka and Vaclav Hlavac, 3e, Springer US.

Reference books:

1. "Fundamentals of Digital Image Processing", Anil K. Jain, PHI.
2. "Digital Image Processing and Analysis", B. Chanda and D. Dutta Mujumdar, PHI.

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

POs met through Gaps in the Syllabus: NA

Topics beyond syllabus/Advanced topics/Design: NA

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

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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	1	2	3
CO1	3	2	2	1	2	1	1	1	1	2	2	3	2	3
CO2	3	3	2	2	3	1	1	1	1	2	2	3	2	3
CO3	3	3	3	2	3	1	1	1	2	2	2	3	3	2
CO4	3	2	3	2	3	1	1	1	2	2	2	3	3	2
CO5	3	3	3	2	3	1	1	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, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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
Bio-Medical Electronics & Signal Processing

Course Code: EC24433
Course Title: Bio-Medical Electronics & Signal Processing
Pre-requisite(s): Signals and Systems, Electronic Measurements, Probability Theory
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

Course Objectives

This course envisions to impart to students to:

1.	Understand the origin of bioelectric potential signals
2.	Understand the methods of measuring biomedical signals in the design and development of medical equipment.
3.	Understand time domain and frequency domain analysis of ECG signals
4.	Understand time domain and frequency domain analysis of EEG signals
5.	Apply machine learning techniques for biomedical signals.

Course Outcomes

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

CO1	Understand different types of biomedical signals
CO2	Understand and analyse the dynamic characteristics of biomedical systems and modelling
CO3	Apply the methods of measuring biomedical signals in the design and development of medical equipment.
CO4	Apply specific mathematical techniques and solve problems in ECG signals
CO5	Implement various signal processing techniques to model EEG signals
CO6	Design and Develop machine learning techniques for biomedical signals.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Bioelectric Potential origin** Origin of Bioelectric Potential, Electrocardiogram (ECG), Origin of ECG Waveform, Electroencephalogram (EEG), Evoked Potentials, Electromyogram (EMG), Potentials generated during muscle action	**8**

Module – II **Biopotential Electrodes and transducers for biomedical applications** Electrode electrolyte Interface, Surface Metal Plate Electrodes, Needle and Wire electrodes, Microelectrodes, Stimulating Electrodes, General features of Biomedical Instrumentation systems, variable resistance transduces, Variable inductance transducers, piezoelectric transducers	**9**
Module – III **Electrocardiography** Time domain analysis of ECG, Preprocessing of ECG -Filtering for removal of artifacts: ECG signal processing in time domain: Frequency domain analysis of ECG: FFT Algorithm, Higher order spectral analysis of ECG. Multi resolution analysis of ECG signal. Filtering for Removal of artifacts in ECG	**8**
Module – IV **Neurological Signal Processing** Analysis of EEG, EEG rhythms, Estimation of the spectrum in EEG, Modeling EEG- linear, stochastic models - Nonlinear modeling of EEG, artifacts in EEG & their characteristics and processing, Evoked potentials- noise characteristics, Multi resolution analysis of EEG signals	**8**
Module – V Pattern classification–supervised and unsupervised classification, Neural networks, Support vector Machines, Hidden Markov models.	**6**

Textbooks:

1. C. Raja Rao, SK Guha, Principles of Medical Electronics and Biomedical instrumentation, Universities Press, 2001.
2. John G Webster, ―Medical Instrumentation – Application and Design‖, 4th ed., John Wiley and Sons, 2009.
3. Leslie Cromwell, Fred. J. Weibell, Erich. A. Pfeiffer, ―Biomedical Instrumentation & Measurements, 2nd ed., Pearson Education., 2001.
4. Biomedical Signal Analysis, Rangaraj M. Rangayyan , 2015 Wiley-IEEEPress, 2nd Edition.
5. https://nptel.ac.in/courses/108/105/108105101/

Reference Books:

1. Biomedical Digital Signal Processing, Willis J Tompkins, Prentice Hall India Private Limited, First Edition, 2006.
2. Eugene N. Bruce, Biomedical Signal Processing and Signal Modeling, John Wiley & Sons, 2000

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

https://nptel.ac.in/courses/108/105/108105101/

POs met through Gaps in the Syllabus

It may be met through laboratory simulations, experiments, and design problems.

Topics beyond syllabus/Advanced topics/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 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	1	2	3
CO1	2	2	3	3	2	3	2	3	3	3	3	3	3	2
CO2	2	2	3	3	2	3	2	3	3	3	3	3	3	2
CO3	2	2	3	3	2	3	3	3	3	3	3	3	3	2
CO4	2	2	3	3	2	3	2	3	3	3	3	3	3	2
CO5	1	1	1	1	1	1	1	1	1	0	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		
CD9	Simulation		

COURSE INFORMATION SHEET

Deep Learning

Course Code: EC24435
Course Title: Deep Learning
Pre-requisite(s): Linear Algebra, Probability Theory, Machine Learning
Co- requisite(s): N/A
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VII/04
Branch: ECE

Course Objectives

This course enables the students:

1.	To provide a comprehensive understanding of the foundational concepts of deep learning.
2.	To equip students with the mathematical tools and techniques necessary for building and analyzing deep learning models.
3.	To explore the architecture and functionality of neural networks.
4.	To introduce advanced deep learning models.
5.	To apply deep learning models to solve various modern engineering problems.

Course Outcomes

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

CO1	Demonstrate a clear understanding of the evolution and applications of deep learning across diverse fields.
CO2	Apply mathematical concepts to understand the functionality of deep learning models.
CO3	Design and optimize deep neural networks (DNNs) for practical machine learning problems.
CO4	Implement advanced deep learning architectures to solve computer vision tasks.
CO5	Analyze real-world scenarios and develop deep learning-based solutions.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I History of Deep Learning, Deep Learning Success Stories, Applications of Deep Learning. Applied mathematics for Deep learning: Eigen Values and	**8**

Eigen vectors, Basis and Feature space, Principal Component Analysis (PCA), Bias and Variance, Overfitting and under-fitting	
Module – II McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Activation functions, Perceptron Learning Algorithm and Convergence, Multilayer Perceptrons (MLPs), Representation Power of MLPs (XOR problem), Loss functions, Optimization techniques: Gradient Descent (GD), Momentum Based GD, Stochastic GD, AdaGrad, RMSProp, Adam.	**8**
Module – III Hyperparameters, train, test and validation set, Regularization for DL: Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Greedy Layer wise Pre-training, activation functions, weight initialization methods, Batch Normalization.	**8**
Module – IV Autoencoders and relation to PCA, Denoising autoenders, Sparse autoencoders, Convolutional Neural Networks, LeNet, AlexNet, VGGNet, GoogLeNet, ResNet, Object Detection, RCNN, YOLO.	**8**
Module – V Recurrent Neural Networks, Vanishing and Exploding Gradients, Gated Recurrent Units (GRUs), Long Short-Term Memory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs, Attention Mechanism, Generative Adversarial Networks (GANs).	**8**

Text Books:

1. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Publisher: MIT Press
2. Deep Learning, by John D Kelleher, MIT Press

Reference Books:

1. "Pattern Recognition and Machine Learning" by Christopher M. Bishop Publisher: Springer
2. "Deep Learning with Python" by François Chollet, Publisher: Manning Publications

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

POs met through Gaps in the Syllabus: NA

Topics beyond syllabus/Advanced topics/Design: NA

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

Course Outcome (CO) Attainment Assessment Tools and Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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	1	2	3
CO1	3	2	1	1	2	1	1	1	2	2	3	2	3	2
CO2	3	3	2	2	2	1	1	1	1	2	2	2	3	3
CO3	3	3	3	2	3	1	1	1	2	2	2	2	3	3
CO4	3	3	3	2	3	1	1	1	2	2	2	3	3	3
CO5	3	3	3	3	3	2	1	2	2	3	3	2	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, CD3, CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD8
CD3	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

Electronic Packaging

Course Code: EC24437
Course Title: Electronic Packaging
Pre-requisite(s): Basic Electronics, Electronic Devices
Co-requisite(s): NA
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: VII/4
Branch: Electronics and Communication Engineering

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	Recognize packaging materials.
CO4	Develop a compact system using electronic packaging.
CO5	Recognize the need for electronic packaging for solve day-to-day life IC packaging problems.

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I **Introduction to Electronic Packaging:** Fundamental of Electronic packaging, issue in electronic packaging, hierarchy of interconnection levels, blue gene, breakthrough in chip packaging technology, SMD benefits and drawback.	**8**
Module – II **Chip Scale Packaging:** Step packaging, silicon wafer, low density SMD process from silicon wafer to package, wafer preparation and dicing, die attach and wire bonding, molding& solder plating, marking and lead trim, chip attachment to the package substrate, chip package connection: tape automated bonding, flip-chip.	**8**

Module – III **Materials used in electronic packaging:** 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.	**8**
Module – IV **Electrical model of the package:** SPICE Simulation for strong and weak driver, parasitic capacitance as function of the interconnect, crosstalk, power integrity and distribution, ground bounce, power/ground count, evolution in power/ground layout, manufacturability, testability, evolution technology, reliability.	**8**
Module – V **IC package types:** 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).	**8**

Textbooks:

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): Hands-on-practical for CMOS IC fabrication.

POs met through Gaps in the Syllabus: NA

Topics beyond syllabus/Advanced topics/Design: NA

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

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

Direct Assessment

Exam	Components	Marks	Total Marks
Internal Evaluation	A. First Quiz	10	50
	B. Mid Semester Examination	25	
	C. Assignment	10	
	D. Teacher's Assessment	5	
End Semester Examination		50	50
		Total	100

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**	**1**	**2**	**3**
CO1	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO2	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO3	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO4	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO5	3	3	1	2	3	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	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD4, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD4, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD4, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2, CD3, CD4, 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
Sensors and Transducers

Course Code: EC24259
Course title: **Sensors and Transducers**
Pre-requisite(s): N/A
Co- requisite(s): N/A
Course type: Open Elective
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. TECH (Open elective)
Semester / Level: IV/ 02
Branch: Allied

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)**
Module – I **Introduction** Introduction about sensors and transducers, Principles of operation and their classification, characteristics of sensors, Errors in measurement.	**6**
Module – II **Resistive and Inductive Transducer** Resistive transducers: Potentiometers, metal and semiconductor strain gauges and signal conditioning circuits, strain gauge applications: load and torque measurement, RTD, Thermistor, LDR, Self and mutual inductive transducers, LVDT, RVDT, eddy currents transducer	**10**
Module – III **Capacitive and Piezoelectric transducer** 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.	**10**
Module – IV **Smart Sensor** Principle, design approach, interface design, configuration supports, communication in smart transducer network. HART protocol.	**8**
Module – V **Recent trends in sensor technology** Digital transducer, Principles and applications of Fibre optic sensor, MEMS sensor, Bio sensor, Silicon sensor, sensors for robotics.	**6**

Text Books:

1. Sensors and Transducers, by D. Patranabis. 2nd 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, 2nd Edition, 2011.

Reference Books:

Sensor and signal conditioning by John G. Webster, Wiley Inter Science,2nd 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
Assignment	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	1	2	3
CO1	3	2	3	3	2	0	2	3	3	3	3	2	2	1
CO2	2	3	3	3	2	0	2	3	3	3	2	2	2	1
CO3	2	3	3	3	2	0	2	3	3	3	2	2	2	1
CO4	2	2	3	3	2	0	2	3	3	3	2	2	2	1
CO5	2	3	3	3	2	0	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
Digital Computer Electronics

Course Code: EC24261
Course title: Digital Computer Electronics
Pre-requisite(s): N/A
Co- requisite(s): N/A
Course type: Open Elective
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. TECH (Open elective)
Semester / Level: IV/ 02
Branch: Allied

Course Objectives

This course envisions to impart to students to:

1	Various Logic Implementation in Mechanical Electrical and Electronic systems
2	Design of combinational circuits and their applications
3	Design of Sequential circuits and their applications
4	Design of a simple as possible computer system
5	Design of DAS, Data Logger and Microprocessor based real time control systems

Course Outcomes

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

CO1	Able to understand and demonstrate the logic implemented in various control systems.
CO2	Able to design and implement combinational logic circuit for a given application.
CO3	Able to design and implement sequential circuit for a given application.
CO4	Able to demonstrate the working of a computer system
CO5	Able to design of DAS, Data Logger and Microprocessor based real time control systems

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Implementation of various logic gates and their applications: AND, OR, NAND, NOR, NOT, EX-OR and EX-NOR gates, Design of ADDER, SUBTRACTOR, BCD Adder, 1-bit ALU, ENCODER, DECODER using Logic gates. Example of various logic implemented in Mechanical, Electrical and Electronic Systems for ON/OFF control.	**8**
Module – II Implementation of various flip flops and their applications: RS, JK and D Flip Flops, Registers, SISO, PIPO registers with Load and Enable control lines, Counters, Controlled binary counter, Ring Counter, UP/DOWN Counters, Modulo 10 Counter. Examples of Counting of Events, display of count in Seven Segment display system, Alarm generation with terminal counts.	**8**
Module – III Design of Memory Elements: ROM, PROM and EPROM, BUS ORGANISED COMPUTERS, RAM, Schematic diagram of a RAM CHIP, Functions of a Various pins of a Memory chip.	**8**
Module – IV Simple as possible computer architecture, concepts with stress on timing diagrams, Instruction and Opcodes, Microinstructions, Opcode Fetch and Execution cycle, Hardware control Matrix, Macroinstructions, Microprogramming, Bus concepts.	**8**
Module – V Data acquisition system and Data logger. Implementation of ON/OFF control and continuous control using Microprocessors and Microcontrollers.	**8**

Text Books:

1. Digital Computer Electronics, 2/e. by A. P. Malvino.
2. “Computer-Based Industrial Control”, by Krishna Kant, PHI.

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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**	**1**	**2**	**3**
CO1	3	2	3	3	0	1	2	3	3	3	3	2	2	1
CO2	2	3	3	3	0	1	2	3	3	3	3	2	2	1
CO3	2	3	3	3	0	1	3	3	3	3	3	2	2	1
CO4	2	2	3	3	0	1	2	3	3	3	3	2	2	1
CO5	2	3	3	2	0	1	2	3	3	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, 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
Introduction to VLSI Design

Course code: EC24263
Course Title: Introduction to VLSI Design
Pre-requisite(s): Basic Electronics
Co-requisite(s): NA
Credits: L: 3 T: 0 P: 0 C: 3
Class schedule per week: 03
Course Type: Open Elective
Class: B. Tech.
Semester / Level: IV/02
Branch: Allied

Course Objectives

This course enables the students to:

1.	Understand the static and dynamic behavior of MOSFET and CMOS inverter.
2.	Interpret the characteristics of combinational circuits in CMOS.
3.	Appraise and analyse the characteristics of sequential logic circuits in CMOS.
4.	Design semiconductor memory circuits.
5.	Create layout of CMOS circuits and design I/O pads.

Course Outcomes

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

CO1	Describe short-channel MOSFETs, combinational, sequential, and memory circuits.
CO2	Classify the combinational, sequential, and memory circuits.
CO3	Sketch the combinational, sequential, and memory circuits.
CO4	Design various combinational, sequential, and memory circuits.
CO5	Solve day-to-day life problems using electronic circuits

SYLLABUS

MODULE	**(NO. OF LECTURE HOURS)**
Module – I **Static and dynamic behavior of MOSFET and CMOS inverter:** Long-channel MOSFET's current model, Threshold voltage, Region of operations, V-I characteristics, Short-channel effects, Static and Dynamic Behaviour of CMOS Inverter: Switching Threshold, Noise Margin formulation, Propagation Delay, Power, PDP, EDP.	**12**

Module – II **CMOS Combinational Circuits:** Static CMOS Design: Pseudo-NMOS, Pass-Transistor, Complementary pass-transistor, Transmission gate, Complementary-CMOS. Dynamic CMOS Design.	**6**
Module – III **CMOS Sequential Circuits:** Timing Metrics for sequential Circuits, Static Latches and Registers, Dynamic Latches and Registers, Pipelining.	**6**
Module – IV **Semiconductor Memories:** Classification of semiconductor memory, Memory decoding and peripheral circuits, Design of 6T SRAM cell, its read/write operation and its layout.	**8**
Module – V Layout and I/O pads: Layouts of universal gates and design rules, I/O pads, ESD protection circuit, bidirectional and Schmitt trigger in the Input pad.	**8**

Textbooks:

1. Jan M. Rabaey, A. Chandrakasan, B. Nikolic, "Digital Integrated Circuits: A Design Perspective", 2nd ed., Prentice Hall, 2003.
2. Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design", 3rd ed. McGraw Hill, 2003.
3. Neil H. E. Weste, David Money Harris, "CMOS VLSI Design – A Circuits and Systems Perspective," 4th ed., Addison Wesley, 2011.

Reference books:

1. Neil H. E. Weste, David Money Harris, "CMOS VLSI Design – A Circuits and Systems Perspective," 3rd ed., Pearson Education, 2006.

Gaps in the syllabus (to meet Industry/Profession requirements): Hands-on-practical for CMOS IC (Integrated Circuit) fabrication.

POs met through Gaps in the Syllabus: 10

Topics beyond syllabus/Advanced topics/Design: NA

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

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

Exam	**Components**	Marks	Total Marks
Internal Evaluation	A. First Quiz	10	50
	B. Mid Semester Examination	25	
	C. Assignment	10	

	D. Teacher’s Assessment	5	
End Semester Examination		50	50
		Total	100

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**	**1**	**2**	**3**
CO1	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO2	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO3	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO4	3	3	1	2	3	1	2	2	3	2	2	3	3	1
CO5	3	3	1	2	3	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	Tutorials/Assignments	CO2	CD1, CD2, CD3, CD4, CD8
CD3	Seminars	CO3	CD1, CD2, CD3, CD4, CD8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD3, CD4, CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2, CD3, CD4, 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

Introduction to Communication System

Course Code: EC24321
Course Title: Introduction to Communication System
Pre-requisite(s): N/A
Co- requisite(s): N/A
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech. (Open elective)
Semester / Level: V/ 03
Branch: Allied

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 digial 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)
Module – I 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.	**10**
Module – II Angle modulation, frequency modulation and phase modulation, NBFM, WBFM, generation of FM wave, demodulation of FM wave, superheterodyne receiver, Frequency Division Multiplexing.	**10**
Module – III 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	**7**
Module – IV 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,	**6**
Module – V 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	**7**

Text Books:

1. Herbert Taub, Donald L Schilling and Gautam Saha "Communication Systems" McGraw Hill Education (India), pvt. Ltd., New Delhi, 4th edition, 2013.

Reference Books:

1. Simon Haykin, "Communication Systems" Wiley, 4th edition, 2001.
2. D. Roddy & J. Coolen, "Electronics Communication", 4th 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
Assignment	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	1	2	3
CO1	3	2	2	1	0	0	0	0	0	0	2	3	2	1
CO2	3	3	3	3	2	0	0	0	0	0	1	3	2	2
CO3	3	3	3	3	2	0	0	0	0	0	1	3	2	1
CO4	3	3	3	3	3	0	0	0	0	0	1	3	2	3
CO5	3	3	3	3	2	0	0	0	0	0	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

Introduction to Microcontrollers

Course Code: EC24333
Course title: Introduction to Microcontrollers
Pre-requisite(s): N/A
Co- requisite(s): N/A
Course type: Open Elective
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. TECH. (Open elective)
Semester / Level: V/ 03
Branch: Allied

Course Objectives

This course enables the students:

1.	Explain the basics of microcontrollers and its programming
2.	Develop assembly language programming skill in the student for 8051 microcontrollers for real time simple control systems.
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.	Explain the microcontroller based real time control systems

Course Outcomes

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

CO1	Demonstrate the knowledge about microcontrollers and its programming.
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)
Module – I 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.	**8**
Module – II 8051 Addressing Modes, External Memory Interfacing and Addressing 8051 Instruction types like Data movement, Logic, Arithmetic, Control transfer and Program Control Instructions, 8051 Programming examples like Arithmetic and Logic operation, Branching, Looping, Boolean arithmetic instructions. A few Industrial examples of ON/OFF control.	**8**
Module – III 8051 Interrupts and Timers/counters: Basics of interrupts, 8051 interrupt structure, Timers and Counters, Programming 8051 timers. 8051 Serial Communication, connections to RS-232, Serial communication Programming	**8**
Module – IV 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.	**8**
Module – V Programming of 8051 for Real time I/O and control applications TEMP, PRESSURE, LEVEL etc. monitoring and Control using 8051 microcontroller.	**8**

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

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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	1	2	3
CO1	3	2	3	3	0	1	2	3	3	3	3	2	2	1
CO2	2	3	3	3	0	1	2	3	3	3	3	2	2	1
CO3	2	3	3	3	0	1	3	3	3	3	3	2	2	1
CO4	2	2	3	3	0	1	2	3	3	3	3	2	2	1
CO5	2	3	3	2	0	1	2	3	3	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, 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
Introduction to MEMS

Course code: EC24363
Course title: **Introduction to MEMS**
Pre-requisite(s): N/A
Co- requisite(s): N/A
Credits: L:3 T :0 P :0 C:3
Class schedule per week: 03/week
Class: B. Tech (Open elective)
Semester / Level: VI/ 03
Branch: Allied

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)
Module – I **Introduction** : The History of MEMS Development ,Intrinsic characteristics of MEMS . **Introduction to microfabrication**.: Essential overview of frequently used micro fabrication processes. Thin film deposition techniques ,wafer bonding Silicon Based MEMS processes, MEMS Materials	**10**
Module – II **Essential Electrical and Mechanical Concepts**: 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.	**9**
Module – III **Sensing and Actuation schemes**: Electrostatic Sensors and Actuators, Thermal sensors and actuators, Piezoresistive Sensors, Piezoelectric Sensors and Actuators, Magnetic Actuators.	**8**
Module – IV Introduction of MEMS switches .MEMS Inductor and MEMS capacitor – classification and design issues. MEMS Packaging and Integration. . Role of MEMS packages.	**7**
Module – V **Case studies for selected MEMS Products**: Blood Pressure Sensor, Microphone, Accelerometer, Performance and Accuracy	**6**

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)

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

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

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

Indirect Assessment

2. 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**	**1**	**2**	**3**
CO1	3	3	3	1	0	0	0	2	2	0	0	3	1	1
CO2	3	3	3	3	2	0	0	2	3	1	0	3	1	1
CO3	0	3	3	1	3	0	0	2	3	0	0	3	2	1
CO4	3	3	3	1	0	0	0	0	0	0	2	3	2	1
CO5	3	1	0	0	1	0	0	1	0	1	0	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

Measurement & Instrumentation

Course Code: EC24379
Course Title: Measurement & Instrumentation
Pre-requisite(s): N/A
Co- requisite(s): N/A
Course type: Open Elective
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. TECH. (Open Elective)
Semester / Level: VI/ 03
Branch: Allied

Course Objectives

This course envisions to impart to students to:

1	Learn different methods of measurements
2	Study different analog and digital instruments
3	analyse each block involved in making of DAS
4	Study different types of controllers
5	Learn how develop instrumentation system using Arduino and Raspberry pi.

Course Outcomes

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

CO1	Calculate the errors in measurement.
CO2	Differentiate between moving coli and moving iron instrument
CO3	Explain the function of individual blocks of Data acquisition system.
CO4	Design a PID controller using OP-AMP.
CO5	Develop instrumentation system using Arduino and Raspberry pi.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction of measurements and measurement systems: Significance of measurements, different methods of measurements, Instruments used in measurements, Characteristics of instruments, Errors in measurements.	**8**
Module – II Analogue and Digital Instruments: Classification and Principles of Operation, Working Details Moving Coil (PMMC) and Moving Iron Instruments Construction, DC Ammeter, DC Voltmeter, Digital Voltmeters Digital Multi-meters. CRO: Construction, Basic CRO circuits, Block diagram of a modern oscilloscope, Digital CRO.	**8**
Module – III Introduction about Instrumentation system. Types of Instrumentation system. Data acquisition system and its uses in intelligent Instrumentation system. Detail study of each block involved in making of DAS. Data logger	**8**
Module – IV Concepts of Control Schemes, Types of Controllers. ON/OFF controller and continuous controller. Closed loop controller design procedure. PID controller, tuning of PID controller. Implementation of PID controller using OP-AMP.	**8**
Module – V Introduction to Ardiono Uno and its programming. Introduction to Raspberry Pi and its programming. Development of different instrumentation system using Arduino and Raspberry pi: Temperature, Pressure, Liquid level, Distance.	**8**

Text Books:

1. Electrical & Electronics Measurements and Instrumentation by A.K Sawhney, Dhanpat Rai & Sons.
2. Process control Instrumentation Technology by CD Johnson, PHI Learning

Reference Books:

1. Transducers and Instrumentation, by Murthy D. V. S., Prentice Hall, 2nd Edition, 2011.
2. Programming Arduino: Getting Started with Sketched, Second Edition by Simon Monk
3. Programming the Raspberry Pi, Second edition: Getting Started with Python by Simon Monk

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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	1	2	3
CO1	3	2	3	3	0	1	2	3	3	3	3	2	2	1
CO2	2	3	3	3	0	1	2	3	3	3	3	2	2	1
CO3	2	3	3	3	0	1	3	3	3	3	3	2	2	1
CO4	2	2	3	3	0	1	2	3	3	3	3	2	2	1
CO5	2	3	3	2	0	1	2	3	3	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, 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

Introduction to Signal Processing

Course Code: EC24439
Course Title: Introduction to Signal Processing
Pre-requisite(s): N/A
Co- requisite(s): N/A
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech. (Open elective)
Semester / Level: VII/ 04
Branch: Allied

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

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction and Basics: Signals and Systems; Classification of Signals, System Properties; Linear Algebra Basics-Vectors, Orthogonality, Eigenvalues and Eigenvectors.	**6**
Module – II 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.	**8**
Module – III 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.	**10**
Module – IV 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.	**8**
Module – V 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	**8**

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
Assignmnt	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	1	2	3
CO1	2	2	0	2	1	0	0	1	1	1	2	2	2	1
CO2	3	3	0	2	2	0	0	1	2	1	2	2	2	1
CO3	2	3	1	1	3	0	0	1	1	1	2	2	2	1
CO4	3	3	0	2	3	0	0	1	1	1	2	2	2	1
CO5	3	2	1	1	2	0	0	1	1	1	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, 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
Electronics Technology

Course Code: EC24441
Course title: Electronics Technology
Pre-requisite(s): N/A
Co- requisite(s): N/A
Course type: Open Elective
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. TECH. (Open elective)
Semester / Level: VII/ 04
Branch: Allied

Course Objectives

This course envisions to impart to students to:

1	Know analog electronic devices and applications
2	Know digital electronic devices and applications
3	Understand electronic communication technology
4	Know microcontroller and its applications
5	Understand Industrial Instrumentation and control, and home appliance devices

Course Outcomes

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

CO1	Design the amplifiers and filters needed for electronic system
CO2	Design the digital systems
CO3	Apply the modulation and demodulation techniques in communication
CO4	Program the microcontrollers for different applications
CO5	Use the electronics technology for Industry and home appliances

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Analog Electronics:** Applications of Diode, Application of BJT as amplifier and switch, Op-Amp and its advantages, Application of Op-Amp: Inverting and non-inverting amplifier, adder, subtractor, Filters etc.	**8**
Module – II **Digital Electronics:** Logic gates, Adder-Subtractor, Encoder, Decoder, Multiplexer, De-multiplexer; Flip-Flops; Shift Registers; Counters; A/D and D/A converters.	**8**
Module – III **Communication Technology:** Need of Modulation in communication, Overview of Analog communication techniques AM, FM, PM, Pulse Modulation, Overview of Digital Communication Techniques, Cellular Communication System	**8**
Module – IV **Microcontroller & Computer Architecture:** Basic block diagram of a typical computer architecture; Basic working principle of ALU and control unit; processor instruction format; Introduction to I/O operation. Example of industrial applications	**8**
Module – V **Industrial Instrumentation system:** Introduction, Types, Data acquisition system, Concept of Industrial Controllers, PLC. **Consumer Electronics:** Working principles of DVD system, LED TV, Inverter, Digital Camera system, Microwave ovens, Washing Machines, Air Conditioners and Refrigerators.	**8**

Recommended Books:

1. Integrated Electronics: Analog and Digital Circuits and Systems, Millman J., Halkias C.C., Parikh Chetan, Tata McGraw-Hill, 2/e.
2. Digital Logic and Computer Design, Mano M. M., Pearson Education, Inc, Thirteenth Impression, 2011.
3. Electronics Explained, Lou Frenzel, Elsevier, 2010.
4. Haykin S., Moher M., “Introduction to Analog & Digital Communications”, Wiley
5. Electronics Technology Handbook, Neil Sclater, McGraw Hill, 1999.
6. S.P. Bali, Consumer Electronics, Pearson Education.
7. R. R. Gulati, “Monochrome and Color Television”, New Age International Publisher
8. B. R. Gupta and V. Singhal, “Consumer Electronics”, S. K. Kataria & Sons
9. Process control Instrumentation Technology by CD Johnson, PHI Learning

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Assignment	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	1	2	3
CO1	3	2	3	3	0	1	2	3	3	3	3	2	2	1
CO2	3	3	3	3	0	1	2	3	3	3	3	2	2	1
CO3	3	3	3	3	0	1	3	3	3	3	3	2	2	1
CO4	3	2	3	3	0	1	2	3	3	3	3	2	2	1
CO5	3	3	3	3	0	1	2	3	3	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, 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
Analog and Digital Circuit Design

Course code: EC24190
Course title: Analog and Digital Circuit Design
Type of Course: Vocational Course I
Pre-requisite(s): N/A
Co- requisite(s): N/A
Credits: L:1 T:0 P:4 C:3
Level: 01
Branch: ECE

Course Objectives

This course enables the students:

1.	To understand the operations and characteristics of BJTs and MOSFETs.
2.	To know the operation of analog-to-digital converter and digital-to-analog converter circuits.
3.	To design half adder, full adder circuits, Seven-Segment display unit, multiplexers and demultiplexer.
4.	To understand the operation of flip-flops and counters.
5.	To design the timer circuits.

Course Outcomes

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

CO1	Measure the basic characteristics of BJTs, MOSFETs and RC circuits.
CO2	Implement logic gates for various combinational circuits.
CO3	Design sequential circuit using logic gates.
CO4	Design analog-to-digital converter and digital-to-analog converter circuits.

SYLLABUS

Module-1

- Study and measure the I-V characteristics of an NPN transistor in Common Emitter (CE) mode.
- Study and measure the Id-Vd and Id-Vg characteristics of an enhancement mode n-MOSFET and a depletion mode n-MOSFET.
- Study and design of a low pass and high pass RC circuits for a given cutoff frequency and obtain its frequency response.

Module-2

- Study and design of R-2R Ladder type 4-bit D/A converter.
- Study and design of 4-bit comparator type A/D Converter.

Module-3

- Study and design Half Adder and Full Adder circuits using logic gates.
- Design and implement Seven-Segment display unit using IC-7447.

Module-4

- Study and design 8:1 multiplexer and 1:4 demultiplexer.
- Study and design of S-R and J-K Flip-Flops using NAND gates.

Module-5

- Study and design 4-bit binary counter.
- Study and design timer circuits using IC555 timer.

Books Recommended

1. “Electronic Devices and Circuit Theory,” Robert L. Boylestad, Louis Nashelsky, Pearson Education
2. “Modern Digital Electronics”, R P. Jain and Kishor Sarawadekar, 5th Edition, McGraw 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
Progressive Evaluation	**(60)**
Attendance	**12**
Day-to-day performance	**06**
Lab Viva	**20**
Lab file	**12**
Lab Quiz-I	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II	**10**
Lab Performance Test	**30**

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**	**1**	**2**	**3**
CO1	3	2	2	2	3	1	0	1	1	1	1	2	2	2
CO2	3	2	2	2	3	1	0	1	1	1	1	2	2	2
CO3	3	2	2	2	3	1	0	1	1	1	1	2	2	2
CO4	3	2	2	2	3	1	0	1	1	1	1	2	2	2

Correlation Levels 1, 2 or 3 as defined below:

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

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, CD3, CD5, CD9
CD2	Tutorials/Assignments	CO2	CD1, CD3, CD5, CD9
CD3	Seminars/ Quiz (s)	CO3	CD1, CD3, CD5, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD3, CD5, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD3, 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
Electronic Equipments Servicing and Maintenance

Course code: EC24192
Course title: Electronic Equipments Servicing and Maintenance
Type of Course: Vocational Course II
Pre-requisite(s): N/A
Co- requisite(s): N/A
Credits: L:1 T:0 P:4 C:3
Level: 01
Branch: ECE

Course Objectives

This course enables the students:

1.	To know the working and testing of resistors, capacitances, inductors and LDRs.
2.	To know the working and testing of various diodes.
3.	To know the working and testing of various BJTs, MOSFETs and Thyristors.
4.	To understand the working of amplifier circuits using op-amp.
5.	To analyse faults of the basic electronic devices and circuits.

Course Outcomes

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

CO1	Test the various passive components and measure their characteristics.
CO2	Test the various active components and measure their characteristics.
CO3	Design and testing of amplifier circuits using op-amp.
CO4	Determine and repair the fault of electronic circuits.

SYLLABUS

Module-1
Passive Components and Their Testing
Resistors, Failures in fixed resistors, testing of resistors, variable resistors, variable resistors as potentiometers, failures in potentiometers, testing of potentiometers, servicing potentiometers.

Module-2
LDRs and Thermistor Types of capacitors and their performance, Failures in capacitors, testing of capacitors and precautions therein, variable capacitor types, Testing of inductors and inductance measurement.

Module-3
Testing of Semiconductor Devices
Types of semiconductor devices, Causes of failure in Semiconductor Devices, Types of failure Test procedures for Diodes, special types of Diodes.

Module-4 Test of Bipolar Junction Transistors, Field Effect Transistors, Thyristors, Operational Amplifiers, Fault diagnosis in op-amp circuits.
Module-5 Soldering and Desoldering, Troubleshooting of SMPS

Books Recommended

1. Modern Electronic Equipment: Troubleshooting, Repair and Maintenance by Khandpur, TMH
2. Electronic Instruments and Systems: Principles, Maintenance and Troubleshooting by R. G. Gupta Tata McGraw Hill Edition
3. Electronic Testing and Fault Diagnosis by G. C. Loveday, A. H. Wheeler Publishing

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
Progressive Evaluation	**(60)**
Attendance	**12**
Day-to-day performance	**06**
Lab Viva	**20**
Lab file	**12**
Lab Quiz-I	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II	**10**
Lab Performance Test	**30**

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**	**1**	**2**	**3**
CO1	3	2	2	2	3	1	0	1	1	1	1	2	2	2
CO2	3	2	2	2	3	1	0	1	1	1	1	2	2	2
CO3	3	2	2	2	3	1	0	1	1	1	1	2	2	2
CO4	3	2	2	2	3	1	0	1	1	1	1	2	2	2

Correlation Levels 1, 2 or 3 as defined below:

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

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, CD3, CD5, CD9
CD2	Tutorials/Assignments	CO2	CD1, CD3, CD5, CD9
CD3	Seminars/ Quiz (s)	CO3	CD1, CD3, CD5, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD3, CD5, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD3, 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

Electronic Instruments and Measurements

Course code: EC24290
Course title: Electronic Instruments and Measurements
Type of Course: Vocational Course III
Pre-requisite(s): N/A
Co- requisite(s): N/A
Credits: L:1 T:0 P:4 C:3
Level: 02
Branch: ECE

Course Objectives

This course enables the students:

1.	To measure Resistance, Inductance and Capacitance using DC and AC bridge techniques.
2.	To measure frequency of unknown signal using AC bridge method.
3.	To know the working of various pressure sensors and temperature sensors.
4.	To understand the working of displacement sensor and level measurement sensor.
5.	To know the operation of digital to analog converter and analog to digital converter.

Course Outcomes

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

CO1	Measure Resistance, Inductance, Capacitance and frequency using DC and AC bridge techniques.
CO2	Comprehend the working of various pressure sensors and temperature sensors.
CO3	Comprehend the working of displacement sensor and level measurement sensor.
CO4	Design digital to analog converter and analog to digital converter.

SYLLABUS

Module-1 Study of Maxwell’s Bridge and measurements of Inductance, DC Resistance, and quality factor of a medium Q coil, Balancing Schering’s Bridge and measurements of Capacitance, and quality factor of a capacitor.
Module-2 Study of Wien’s Bridge Measurement, Balancing Wien’s Bridge and measurements of frequency of unknown sinusoidal signals.
Module-3 Study and measurement of pressure using diaphragm and strain gauge, Study and measurement of temperature using RTD, Thermocouple, and Thermistor

Module-4
Study and measurement of displacement using LVDT, study and measurement of the level using Load Cell.

Module-V
Study and design of digital to analog converter using R-2R ladder, study and design of counter type analog to digital converter.

Books recommended:

1. "Electrical and Electronic Measurements and Instrumentation" by A. K. Sawhney.
2. "Modern Electronic Instrumentation & Measurement Techniques" by Helfrick & Cooper.
3. "Electronic Instrumentation", by H. S. Kalsi.

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

<u>Direct Assessment</u>

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	**(60)**
Attendance	**12**
Day-to-day performance	**06**
Lab Viva	**20**
Lab file	**12**
Lab Quiz-I	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II	**10**
Lab Performance Test	**30**

<u>Indirect Assessment</u>

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**	**1**	**2**	**3**
CO1	3	2	2	2	3	1	0	1	1	1	1	2	2	2
CO2	3	2	2	2	3	1	0	1	1	1	1	2	2	2
CO3	3	2	2	2	3	1	0	1	1	1	1	2	2	2
CO4	3	2	2	2	3	1	0	1	1	1	1	2	2	2

Correlation Levels 1, 2 or 3 as defined below:

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

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, CD3, CD5, CD9
CD2	Tutorials/Assignments	CO2	CD1, CD3, CD5, CD9
CD3	Seminars/ Quiz (s)	CO3	CD1, CD3, CD5, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD3, CD5, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD3, 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
Communication Engineering

Course code: EC24292
Course title: Communication Engineering
Type of Course: Vocational Course IV
Pre-requisite(s): N/A
Co- requisite(s): N/A
Credits: L:1 T:0 P:4 C:3
Level: 02
Branch: ECE

Course Objectives

This course enables the students:

1.	To understand the Amplitude Modulation and Demodulation techniques.
2.	To understand the Frequency Modulation and Demodulation techniques.
3.	To know the techniques of Pulse Amplitude Modulation, Pulse Width Modulation, and Pulse Position Modulation.
4.	To understand the Time Division Multiplexing and Pulse Code Modulation.
5.	To know Amplitude Shift Keying, Frequency Shift Keying and Phase Shift Keying.

Course Outcomes

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

CO1	To design the circuits for AM, FM and observe the waveforms.
CO2	Comprehend PAM, PWM and PPM and observe the waveforms.
CO3	Understand TDM and PCM and observe the waveforms.
CO4	Understand ASK, FSK and PSK and observe the waveforms.

SYLLABUS

Module-1 Generation and detection of Amplitude Modulated (AM) wave.
Module-2 Generation and detection of Frequency Modulated (FM) wave.

Module-3
Study of Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM) and their generation and detection.

Module-4
Investigation of Time Division Multiplexing (TDM) System, Investigation of Pulse Code Modulation (PCM) system.

Module-V
Study of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK) and Phase Shift Keying (PSK) and observation of their waveforms.

Books Recommended

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.

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
Progressive Evaluation	**(60)**
Attendance	**12**
Day-to-day performance	**06**
Lab Viva	**20**
Lab file	**12**
Lab Quiz-I	**10**
End SEM Evaluation	**(40)**
Lab Quiz-II	**10**
Lab Performance Test	**30**

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**	**1**	**2**	**3**
CO1	3	2	2	2	3	1	0	1	1	1	1	2	2	2
CO2	3	2	2	2	3	1	0	1	1	1	1	2	2	2
CO3	3	2	2	2	3	1	0	1	1	1	1	2	2	2
CO4	3	2	2	2	3	1	0	1	1	1	1	2	2	2

Correlation Levels 1, 2 or 3 as defined below:

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

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, CD3, CD5, CD9
CD2	Tutorials/Assignments	CO2	CD1, CD3, CD5, CD9
CD3	Seminars/ Quiz (s)	CO3	CD1, CD3, CD5, CD9
CD4	Mini Projects/Projects	CO4	CD1, CD3, CD5, CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD3, 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		