Department of Electrical and Electronics Engineering

Birla Institute of Technology, Mesra, Ranchi – 835215 (India)

Course Information Sheet
for
M.Tech in Electrical Engineering (Control System)

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 Undergraduate, 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. programs and research projects.
- To develop effective teaching and 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 an internationally recognized center of excellence in academics, research and technological services in the area of ***Electrical and Electronics Engineering*** and related inter-disciplinary fields.

Department Mission

- Imparting strong fundamental concepts to students and motivate them to find innovative solutions to engineering problems independently.
- Developing engineers with managerial attributes capable of applying appropriate technology with responsibility.

- Creation of congenial atmosphere and ample research facilities for undertaking quality research to achieve national and international recognition by faculty and students.
- To strive for internationally recognized publication of research papers, books and to obtain patent and copyrights.
- To provide excellent technological services to industry for the benefit of society.

Program Educational Objectives (PEOs)

PEO 1: To acquire in-depth knowledge of complex Electrical Engineering problems especially in Control Systems to impart ability to discriminate, evaluate, analyze critically and synthesize knowledge pertaining to state of art and innovative research.

PEO 2: To solve complex control system problems with commensurate research methodologies as well as modern tools to evaluate a broad spectrum of feasible optimal solutions keeping in view socio- cultural and environmental factors.

PEO 3: To posses wisdom regarding group dynamics to efficaciously utilize opportunities for positive contribution to collaborative multidisciplinary engineering research and rational analysis to manage projects economically.

PEO 4: To communicate with engineering community and society at large adhering to relevant safety regulations as well as quality standards.

PEO 5: To inculcate the ability for life-long learning to acquire professional and intellectual integrity, ethics of scholarship and to reflect on individual action for corrective measures to prepare for leading edge position in industry, academia and research institutes.

Graduate Attributes (GAs)

GA1: Scholarship of Knowledge

Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.

GA2: Critical Thinking

Analyze complex engineering problems critically, apply independent judgement for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

GA3: Problem Solving

Think laterally and originally, conceptualise and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

GA4: Research Skill

Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyse and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.

GA5: Usage of modern tools

Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.

GA6: Collaborative and Multidisciplinary work

Possess knowledge and understanding of group dynamics, recognise opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

GA7: Project Management and Finance

Demonstrate knowledge and understanding of engineering and management principles and apply the same to one„s own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.

GA8: Communication

Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.

GA9: Life-long Learning

Recognise the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

GA10: Ethical Practices and Social Responsibility

Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

GA11: Independent and Reflective Learning

Observe and examine critically the outcomes of one„s actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

PROGRAM OUTCOMES (POs) for ME (CONTROL SYSTEM)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: Anability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: Recognise the need for continuous learning and will prepare oneself to create, select and apply appropriate techniques and modern engineering and IT tools to solve complex control system problems.

PO5: Demonstrate knowledge of engineering and management principles and apply to manage projects efficiently and economically with intellectual integrity and ethics for sustainable development of society.

PO6: Possess knowledge and understanding to recognize opportunities and contribute to collaborative-multidisciplinary research, demonstrate a capacity for teamwork, decision-making based on open-mindedness and rational analysis in order to achieve common goals.

Semester I
COURSE INFORMATION SHEET

Course code: EE501
Course title: Advanced Digital Signal Processing
Pre-requisite(s): Basics of signals and systems, transform methods, Filter theory.

Credits: 3	L	T	P
	3	0	0

Class schedule per week: 3 Lectures
Class: M.Tech
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	enumerate the basic concepts of signals and systems and their interconnections in a simple and easy-to-understand manner by employing different mathematical operations like folding, shifting, scaling, convolutions, Z-transform etc;
2.	determine transfer function, impulse response and comment on various properties like linearity, causality, stability of a system;
3.	predict time and frequency response of discrete-time systems using various techniques like Z-transform**,** Hilbert transform**,** DFT, FFT;
4.	design digital IIR and FIR filters using filter approximation theory, frequency transformation techniques, window techniques and finally construct different realization structures;
5.	apply DSP processor in processing of 1D and 2D signals.

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

CO1	state sampling theorem and reproduce a discrete-time signal from an analog signal; acquire knowledge of multi rate digital signal processing, STFT and wavelets;
CO2	classify systems based on linearity, causality, shift-variance, stability criteria and represent transfer function of the selected system;
CO3	evaluate system response of a system using Z-transform, convolution methods, frequency transformation technique, DFT, DIF-FFT or DIT-FFT algorithm, window techniques;
CO4	designFIR and IIR filters used as electronic filter, digital filter, mechanical filter, distributed element filter, waveguide filter, crystal filter, optical filter, acoustic filter, etc.;
CO5	construct (structure) and recommend environment-friendly filter for real- time applications.

SYLLABUS

EE501 Advanced Digital Signal Processing

Module I

Introduction: Overview of discrete time signal and systems, Types of discrete time systems, Analysis of discrete-time linear time invariant systems, Multirate signal processing: Decimation by factor D, I sampling rate conversion by a rational factor I/D. Z-transform, Properties of Z-transform, Inverse of Z-transform, Chrip Z-ransform, Zury's test for stability, Digital filter structures: Direct form I & II, Cascade, Parallel and Ladder realizations.

(8L)

Module II

Frequency domain analysis: Discrete Fourier transform (DFT), Inverse DFT, Inter relationship with z-transform and Hilbert-transforms, Discrete Hilbert transform, FFT algorithms-Decimation in time and decimation in frequency. Spectral analysis using DFT, Short term DFT.

(8L)

Module III

Filter function approximation, transforms and IIR filter design: Review of approximation of ideal analog filter response. Butterworth, Chebyshev type I & II, IIR filter designs based on impulse invariant and Bilinear transformation.

(8L)

Module IV

Design of FIR Filters: Characteristic of FIR filters with linear phase, Symmetric and antisymmetric FIR filters, design of linear phase FIR filters using windows and frequency sampling methods, comparison of FIR and IIR filters.

(8L)

Module V

DSP Processor and applications: Introduction to DSP processor, Types of architectures, DSP support tools, code composer studio, compiler, assembler and linker, Introduction TMS320 C6x architecture, functional units, fetch and execute packets, pipe lining, registers, Linear and circular addressing modes. DSP applications in the area of biomedical signal, speech, and image.

(8L)

Books Recommended:

Text Book

1. John G. Proakis, Dimitris G. Mamalakis, Digital Signal Processing, Principles, Algorithms and Applications.

2. Alan V. Oppenheim Ronald W. Schafer, Digital Signal Processing, PHI, India.

Reference Book

1. Antonious, Digital Filter Design, Mc-Graw-Hill International Editions.
2. S. Salivahanan C Gnanapriya, Digital Signal Processing, Tata McGraw Hill Education Private Limited.
3. A. NagoorKani, Digital Signal Processing, McGraw Hill Education Private Limited.

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

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

1. Visualize different signal processing techniques in real time.
2. Application of real time implementation of digital filter.

POs met through Gaps in the Syllabus:PO5 & PO6

Topics beyond syllabus/Advanced topics/Design:

Adaptive signal processing, Image processing.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

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

Indirect Assessment

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

POs met through Topics beyond syllabus/Advanced topics/Design: PO5 & PO6

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 PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	-	-	-
CO2	3	2	1	2	-	1
CO3	3	1	2	3	-	1
CO4	2	2	2	3	2	2
CO5	2	2	3	1	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

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

COURSE INFORMATION SHEET

Course code: EE503
Course title: Modern Control Theory
Pre-requisite(s): B.E./B.Tech. in ECE/EEE with basic courses on Control Theory
Co- requisite(s): Linear Algebra

Credits: 3	L	T	P
	3	0	0

Class schedule per week: 03
Class: M.Tech.
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	state basic concepts of state variables, state diagrams, controllability, observability;
2.	extend comprehensive knowledge of mathematical modelling of physical system;
3.	illustrate basics of transformations and decompositions for controllability and observability tests;
4.	enhance skills with application of different control strategy for designing a control problem;
5.	design controller for any type of linear plants.

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

CO1	demonstrate an understanding of the building blocks of basic and modern control systems by creating mathematical models of physical systems in input-output or transfer function form;
CO2	organize state representations to satisfy design requirements using transformations and decompositions;
CO3	examine state space equations for time domain analysis;
CO4	assess a system for its stability, controllability, and observability properties leading to design of controller and observer in a feedback control system;
CO5	aspire for pursuing a carrier in control, recognize the need to learn, to engage and to adapt in a world of constantly changing technology and play role of team leader or supporter of team.

SYLLABUS
EE503 Modern Control Theory

Module I

Background and Preview, Modelling, Highlights of Classical Control Theory; Block diagram, Transfer functions, State Variables and State Space description of dynamic systems, State diagrams, Differential equations to state diagrams, State diagrams to Transfer function, State diagrams to state and output equations, State equations from system's linear graph.

(8L)

Module II

Fundamentals of Matrix Algebra, Vectors and Linear Spaces, Simultaneous Linear Equations, Eigenvalues and Eigenvectors, Functions of Square Matrices, Similarity Transformations, CCF, OCF, DCF and JCF forms, Decomposition of Transfer Functions, The Caley-Hamilton Theorem and it's applications.

(8L)

Module III

Analysis of Continuous and Discrete-Time Linear State Equations, Local linearization of non-linear models, State Transition Matrix, Significance, Properties and Evaluation of STM, Stability analysis using direct method of Lyapunov.

(8L)

Module IV

Controllability and Observability concept for linear Systems, Relationship among Controllability, Observability and Transfer Functions, Invariant theorems on Controllability and Observability.

(8L)

Module V

Design of Linear Feedback Control Systems, pole placement design through state feedback, Design of servo systems, State observers, Design of Regulator Systems with observers, Design of control systems with Observers, Quadratic Optimal Regulator Systems.

(8L)

Books Recommended:

Text Book

1. Modern Control Theory by Brogan, Pearson, 3rd edition. (**T1)**

2. Systems and Control by Zak, 1st edition, Oxford University Press. **(T2)**

3. Modern Control System Theory by M. Gopal, New Age International(P) Ltd., 2nd edition. (**T3**)
4. Automatic Control Systems by F. Golnaraghi and B.C.Kuo, Wiley Student Edition, 9th edition. (**T4**)
5. Modern Control Engineering by K. Ogata, Pearson, 5th edition (**T5)**

Reference Book

1. Digital Control & State Variable Methods – M. Gopal, Tata McGraw Hill Education. (**R1**)
2. Linear Systems by Thomas Kailath, Prentice-Hall Inc.,1980. (**R2**)

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations.

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

1. Design of real-time industrial projects.

POs met through Gaps in the Syllabus: PO5 & PO6

Topics beyond syllabus/Advanced topics/Design:

1. Design optimization for industrial projects, Fractional order controller.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

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

Indirect Assessment

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

POs met through Topics beyond syllabus/Advanced topics/Design: **PO5 & PO6**

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 PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	1	3	-	-
CO2	3	-	1	3	-	1
CO3	3	1	2	3	-	1
CO4	3	2	2	3	2	2
CO5	3	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

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

COURSE INFORMATION SHEET

Course code: EE505
Course title: System Identification and Adaptive Control
Pre-requisite(s): Fundamentals of signal and system, Digital signal processing,
Credits: 3

	L	T	P
	3	0	0

Class schedule per week: 03
Class: M. Tech.
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	illustrate the process of System Identification and interpret data based identification techniques;
2.	understand the concepts of Time invariant systems identification and apply it to specific real time numerical problems;
3.	illustrate and summarize the techniques of Adaptive Control;
4.	derive necessary and sufficient conditions for Input/Output, Lyapunov (Direct and Indirect) stability;
5.	develop adaptive laws for On-line Parameter Estimation and derive schemes and procedures for Direct Model Reference Adaptive Control.

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

CO1	enumerate the process of System identification and apply the data based identification techniques to identify transfer functions of unknown plant models;
CO2	apply the static and dynamic system identification techniques to identify the estimated states for the unknown or perturbed time invariant plant models;
CO3	state and interpret the concepts of adaptive control and determine Input/Output and Lyapunov stability of a LTI feedback system;
CO4	apply various techniques or laws of adaptation for online parameter estimation and reproduce the results and write effective reports suitable for quality journal and conference publications ;
CO5	design adaptive observers and model reference adaptive control for SISO and MIMO plants and simultaneously recognize the need to learn, to engage and to adapt in a world of constantly changing technology and play role of team leader or supporter of team.

SYLLABUS

EE505 System Identification and Adaptive Control

Module I

Introduction to System Identification: Data based identification (System Response Methods, Frequency Response Methods, Correlation Methods.

(8L)

Module II

Time Invariant Systems Identification: Static Systems Identification, Dynamic Systems Identification.

(8L)

Module III

Introduction to Adaptive Control: Models for Dynamic Systems, Stability.

(8L)

Module IV

On-line Parameter Estimation: Fundamentals of random signals, Spectral estimation, Optimum (Wiener and Kalman) linear estimation, Extended Kalman filter, Particle filter, Parameter Identifiers and Adaptive Observers.

(8L)

Module V

Model Reference Adaptive Control (MRAC): Simple Direct MRAC Schemes, MRC for SISO Plants, Direct MRAC with Unnormalized Adaptive Laws, Direct MRAC with Normalized Adaptive Laws.

(8L)

Books recommended:

Text Books:

1. Systems Identification: An Introduction – Karel J. Keesman, Springer, 2011.
2. Robust Adaptive Control - Petros A. Ioannou and Jing Sun, 1996.
3. Optimization, Estimation and Control - A.E. Bryson & Y.C. Ho
4. Applied Optimal Estimation - A. Gelb, NIT Press, Cambridge
5. Optimal Estimation, Identification and Control - RCK Lee, NIT Press, Combridge, Massachusetts, 1964.
6. Stochastic Optimal Linear Estimation and Control - J.S. Meditch, McGraw Hill, N.Y., 1969.

Course Evaluation:
Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):
Design of real-time industrial projects.
POs met through Gaps in the Syllabus:**PO5 & PO6**

Topics beyond syllabus/Advanced topics/Design:
Advanced topic in adaptive signal processing, Artificial Intelligence Techniques.

POs met through Topics beyond syllabus/Advanced topics/Design: **PO5 & PO6**

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

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

Indirect Assessment

1. Student Feedback on Faculty
2. 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 PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	1	3	-	-
CO2	2	-	1	2	-	-
CO3	2	1	2	2	-	2
CO4	2	2	2	3	2	2
CO5	2	3	3	1	1	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

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

COURSE INFORMATION SHEET

(ELECTIVE-1)

Course code: EE511
Course title: Optimization in Engineering Design
Pre-requisite(s): Fundamental of Engineering Mathematics
Co- requisite(s):

Credits: 3	L	T	P
	3	0	0

Class schedule per week: 03
Class: M.Tech.
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	conceptualize the optimizations in engineering design and model the problem mathematically;
2	understand various optimization methods and algorithms for solving optimization problems;
3	develop substantial interest in research, for applying optimization techniques in problems of engineering and technology;
4	analyze and apply mathematical results and numerical techniques for optimization of engineering problems, while being able to demonstrate solutions through computer programs;
5	formulate the optimization criteria for real time applications.

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

CO1	have a basic understanding of traditional and non-traditional optimization algorithms;
CO2	formulate engineering design problems as mathematical optimization problems;
CO3	use mathematical software for the solution of engineering problems;
CO4	differentiate the various optimization concepts and equivalently apply them to engineering problems;
CO5	evaluate pros and cons for different optimization techniques.

SYLLABUS

EE511 Optimization in Engineering Design

Module I

One-Dimensional Search and Multivariable Optimization Algorithm: Optimality Criteria, Bracketing methods: Exhaustive search methods, Region – Elimination methods; Interval halving method, Fibonacci search method, Golden section search method, Point-estimation method; Successive quadratic estimation method. Optimality criteria, Unidirectional search, Direct search methods: Simplex search method, Hooke-Jeeves pattern search method

(8L)

Module II

Gradient-Based Methods: Newton-Raphson method, Bisection method, Secant method, Cauchy's (Steepest descent) method and Newton's method.

(8L)

Module III

Linear Programming: Graphical method, Simplex Method, revised simplex method, Duality in Linear Programming (LP), Sensitivity analysis, other algorithms for solving LP problems, Transformation, assignment and other applications.

(8L)

Module IV

Constrained Optimization Algorithm: 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.

(8L)

Module V

Advanced Optimization Techniques: Genetic Algorithm, Working principles, GAs for constrained optimization, Other GA operators, advanced GAs, Differences between GAs and traditional methods. Simulated annealing method, working principles. Particle swarm optimization method, working principles.

(8L)

Books Recommended:

Reference Book:

1. Optimization for Engineering Design - Kalyanmoy Deb.
2. Optimization Theory and Applications - S.S. Rao.

3. Analytical Decision Making in Engineering Design – Siddal.
4. Linear Programming – G. Had

Course Evaluation:
Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):
Validation of optimization based designfor industrial projects.
POs met through Gaps in the Syllabus:**PO6**

Topics beyond syllabus/Advanced topics/Design:
Genetic Algorithm based machine design.
POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

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

Indirect Assessment

1. Student Feedback on Faculty
2. 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 PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	1	3	-	-
CO2	3	-	1	3	-	1
CO3	3	1	2	3	-	1
CO4	3	2	2	3	2	2
CO5	3	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

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

COURSE INFORMATION SHEET

Course code: EE515
Course title: Control System Design
Pre-requisite(s): Fundamentals of Mathematics and Physics, Introduction to System Theory, Control Theory
Co- requisite(s): Linear Algebra
Credits: 3 L T P
3 0 0
Class schedule per week: 3
Class: M.Tech.
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	to state the performance characteristics of control systems with specific design requirements and design objectives;
2	to understand the concepts of PD, PI, PID, lead, lag and lag lead controller design in time domain and frequency domain and apply it to specific real time numerical problems;
3	to apply the state feedback controller and observer design techniques to modern control problems and analyse the effects on transient and frequency domain response;
4	to realize and then design digital and analog compensators;
5	design controller for any type of linear plants.

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

CO1	identify the design objectives and requirements of control systems;
CO2	interpret the concepts of PD, PI, PID, lead, lag, lag lead, and discrete data controller design and apply it to solve some design problems;
CO3	apply the state feedback controller design and techniques and outline its effects on system's performance which includes transient response and robustness;
CO4	to develop methodologies to design real time digital and analog compensatorsand reproduce the results and write effective reports suitable for quality journal and conference publications;
CO5	aspire for pursuing a carrier in control, recognize the need to learn, to engage and to adapt in a world of constantly changing technology and play role of team leader or supporter of team.

SYLLABUS

EE515 Control System Design

Module I

Introduction: Performance characteristics of feedback control system & design specification of control loop. Different types of control system applications and their functional requirement. Derivation of load-locus (toque/ speed characteristics of load). Selection of motors, sensors, drives. Choice of design domain & general guidelines for choice of domain. Controller configuration and choice of controller configuration for specific design requirement. Fundamental principles of control system design. Experimental evaluation of system dynamics in time domain and frequency domain

(8L)

Module II

Design of Controller: Design with PD Controller, Time domain interpretation of PD controller, frequency domain interpretation of PD controller, summary of the effects of PD controller. Design with PI controller: Time domain interpretation of PI controller frequency domain interpretation of PI controller, summary of the effects of PI controller, design with PID controller, Ziegler Nichols tuning & other methods.

(8L)

Module III

Design of Compensator: time domain interpretation of lag/lead/lag-lead compensator, frequency domain interpretation of lag/lead/lag-lead compensator, summary of the effects of lag/lead/lag-lead compensator. Forward & feed-forward controller, minor loop feedback control, concept of robust design for control system, pole-zero cancellation design. .

(8L)

Module IV

State Space Model: Sate feedback control, pole placement design through state feedback, state feedback with integral control, design full order and reduced order state observer.

(8L)

Module V

Design of Discrete Data Control System: Digital implementation of analog controller (PID) and lag-lead controllers, Design of discrete data control systems in frequency domain and Z plane.

(8L)

Books recommended:

Text Books:

1. B.C. Kuo, "Automatic Control System", 7th Edition PHI. (T1)
2.M. Gopal, "Control Systems Principles & Design", 2nd Edition, TMH. (T2)
3.J.G. Truxal, "Automatic Feedback Control System", McGraw Hill, New York. (T3)
4.K. Ogata, "Discrete Time Control Systems", 2nd Edition, Pearson Education. (T4)

Reference Books:

1.Norman Nise,"Control System Engineering", 4th Edition. (R1)
2.M. Gopal, "Digital Control & State Variable Method", TMH. (R2)
3.B.C. Kuo, "Digital Control System", 2nd Edition, Oxford. (R3)
4. Stephanie, "Design of Feedback Control Systems", 4^{th} Edition, Oxford. (R4)

Course Evaluation:
Individual assignment, Theory (Quiz and End semester) examinations

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

1. Real time analog design of controllers.
2. Interfacing the controllers with the real time physical plants to identify the effects on system's performance. **PO5 & PO6**

Topics beyond syllabus/Advanced topics/Design:

Advanced robust design methods for different control problems.
Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

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

Indirect Assessment

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

Course Delivery Methods

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

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	2	-	-
CO2	3	2	1	3	-	1
CO3	3	1	2	3	-	1
CO4	3	3	2	3	2	2
CO5	3	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1,CD2,CD6
CO3	CD1,CD2,CD6
CO4	CD1,CD2,CD6
CO5	CD1, CD5

COURSE INFORMATION SHEET

Course code: EE513
Course title: Robotics and Automation
Pre-requisite(s): Engineering Mathematics, Signal and systems, Control Theory, Basic programming knowledge.
Co- requisite(s):

Credits: 3	L	T	P
	3	0	0

Class schedule per week: 03
Class: M.Tech.
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	to explain the characteristics of robots, discuss different types of sensors and basic programming languages used for robotics;
2	to relate direct and inverse kinematics problem of robots and apply methods to solve them and to use techniques for planning robot motions;
3	to explain different methods for control of robotic manipulators;
4	to design suitable controllers and check stability for robotic manipulators;
5	to recommend the use of robotic vision in different applications of robots.

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

CO1	enumerate and explain characteristics of robots, sensors used in robots and basic programming languages;
CO2	correlate direct and inverse kinematics to real life problems and apply the algorithm to solve them;
CO3	explain and analyse different control techniques and evaluate planning algorithms for robot motions;
CO4	assess the use of computer vision/machine vision to different robot applications and appraise the use of artificial intelligence in different field of robotics;
CO5	solve real life applications using direct and inverse kinematics and simulate different controllers;

SYLLABUS

EE513 Robotics and Automation

Module I

Basic components of robotic systems,Robot classification, Robot specifications, Applications, Direct Kinematics: Coordinateframes; Rotations; Homogeneous coordinates; D-H representation; The Arm Equation.

(8L)

Module II

Inverse Kinematics: Inverse kinematics problem, General properties of solutions, Tool configuration, Robotic work cell, Workspace analysis. Trajectory planning. Workspace envelope. Workspace fixtures. Pick and place operation. Continuous-path motion. Interpolated motion. Straight line motion.

(8L)

Module III

Sensing and Control of Robot Manipulators: Different sensors in robotics: Range; Proximity; Touch; Torque; Force and others. Computed torque control; Near Minimum time control; Variable structure control; Non-Linear decoupled feedback control; Resolved motion and Adaptive control.

(8L)

Module IV

Robotic Vision: Image acquisition and Geometry. Pre-processing; Segmentation and Description of 3-D structures; Recognition and Interpretation. .

(8L)

Module V

Robot Arm Dynamics: Lagrange-Euler formulation; Newton Euler formulation; Generalized D'Alembert's equation.

Robot Programming Languages, Robot Intelligence and Task Planning: Characteristics of Robot level languages. Task level languages- with examples C, prolog. Assembly etc. Problem reduction; Use of predicate logic; Robot learning; Expert systems.

(8L)

Books recommended:

Text Book
1. Fundamental of Robotics: Analysis and Control- Robert J. Schilling. **[T1]**
2. Robotics: Control, Sensing,Vision and Intelligence- K.S. Fu, R.C. Gonzalez and Lee. **[T2]**

Reference Book
1. Robotics and Control – R. K. Mittal and I. J. Nagrath. (**R1**)

Course Evaluation:
Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):
Simulation to meet real time implementation of techniques for control of robots

POs met through Gaps in the Syllabus: **1,2,3,4,5,6**

Topics beyond syllabus/Advanced topics/Design:
Simulation given to students as assignments

POs met through Topics beyond syllabus/Advanced topics/Design: **1,2,3,4,5,6**

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

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

Indirect Assessment

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

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Self- learning such as use of NPTEL materials and internets
CD5	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	3	3	-
CO2	3	-	3	3	-	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	-
CO5	3	-	3	3	3	-

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcome	Course Delivery Method
CO1	CD1,CD2,CD4
CO2	CD1,CD2,CD4
CO3	CD1,CD2,CD3,CD4,CD5
CO4	CD1,CD2,CD3,CD4,CD5
CO5	CD1,CD2,CD3,CD4,CD5

COURSE INFORMATION SHEET

Course code: EE517
Course title: Image Processing and Computer Vision
Pre-requisite(s): Basics of signals and systems, transform methods, Filter theory.

Credits: 3	L	T	P
	3	0	0

Class schedule per week: 03
Class: M.Tech
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	understand the basic steps of the digital image processing and basic of computer vision;
2	understand the concepts of Image Transform, Image Restoration, Segmentation and Compression;
3	illustrate and summarize the technique of shape representation, feature extraction, boundary descriptors, and regional descriptors;
4	design adaptive algorithm suitable for image de-noising, object tracking, vision based control etc.;
5	develop adaptive algorithm for other image processing and computer vision applications.

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

CO1	recognise the basic steps of the digital image processing such as Image Transform, Image Restoration, Segmentation and Compression;
CO2	understand the basic concept of computer vision and investigate different associated methodology;
CO3	recapitulate the technique of shape representation, feature extraction, shape representation, feature extraction, edge detection, boundary descriptors, and regional descriptors;
CO4	apply various techniques of image processing for object recognition, motion estimation, object tracking;
CO5	design apply various adaptive algorithm for vision based control, vision for human computer interaction etc.

SYLLABUS
EE517 Image Processing and Computer Vision

Module I

Digital Image Fundamentals: Fundamental steps in Digital Image Processing, Components of an Image processing system, Digital Image Representation, Basic relationship between pixels, Color Modules, Image negatives, Histogram Equalization, Local Enhancement, Image Subtraction, Image Averaging, Smoothing Spatial Filters, Sharpening Spatial Filters.

(8L)

Module II

Image Transform: Fourier Transform, Discrete Fourier Transform, Fast Fourier Transform, Smoothing Frequency Domain filters, Sharpening Frequency Domain filters, Homomorphic filtering, Convolution and Correlation Theorems, Wavelet Transforms, The Fast Wavelet Transforms.

(8L)

Module III

Image Restoration, Segmentation and Compression: Noise Models, Mean filters, Median Filter, Minimum Mean Square Error (Wiener) Filtering, Geometric Mean Filter, Adaptive filters, Periodic Noise Reduction by Frequency Domain filtering, Inverse Filtering, Detection of Discontinuities, Point Detection, Line detection, Edge Detection, Fundamentals of image compression, Redundancy, Image Compression Models, Error-free and Lossy Compression techniques.

(8L)

Module IV

Computer vision Fundamentals: Shape Representation, Description and Feature Extraction: Deformable curves and surfaces, Snakes and active contours, Level set representations, Linear Filters, Texture, Edge detection, Boundary Descriptors, Regional Descriptors.

(8L)

Module V

Image Processing and Computer Vision Applications: Denoising of Image as pre-processing, Object recognition, Motion estimation, Object Tracking, Vision based control, vision for human computer interaction.

(8L)

Text Books:

1. R.C.Gonzalez and Richard E Woods, Digital Image Processing, 2e, Pearson Education.
2. D. A. Forsyth, J. Ponce, Computer Vision: A Modern Approach, PHI Learning 2009

Reference Book:
1. B.Chanda and D. Dutta Majumdar, Digital Image Processing and Analysis, PHI.

Course Evaluation:
Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):
Design of real-time industrial projects.
POs met through Gaps in the Syllabus:**PO4 & PO5**

Topics beyond syllabus/Advanced topics/Design:
Object Tracking, Video compression.
POs met through Topics beyond syllabus/Advanced topics/Design: **PO5 & PO6**

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

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

Indirect Assessment

1. Student Feedback on Faculty
2. 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 PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	1	1
CO2	2	1	1	3	1	1
CO3	2	2	3	3	2	1
CO4	3	1	2	3	2	2
CO5	3	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

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

COURSE INFORMATION SHEET

Course Code: EE 597
Course title: Reliability Engineering (Open Elective)
Pre-requisite(s): Engineering Mathematics, Probability Theory
Co- requisite(s):

Credits: 3	L	T	P
	3	0	0

Class schedule per week: 3
Class: M.Tech.
Semester / Level: I/05
Branch:
Name of Teacher:

Course Objectives
This course enables the students to:

1.	define probability theory and relate the concept of reliability of systems;
2.	understand general reliability mathematics applicable to all systems;
3.	understand Markov chains, and application of Markov models in reliability analysis of systems;
4.	evaluate reliability of systems using Markov models and available reliability parameters of systems;
5.	use frequency and duration technique for various reliability analysis problems.

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

1.	understand the general reliability concept and mathematics;
2.	identify events or causes responsible for unreliability of systems through failures;
3.	evaluate the associated system risk and thus finding solutions for minimizing the risks to an acceptable level;
4.	apply engineering knowledge and design techniques to prevent or to reduce the likelihood or frequency of failures for different systems;
5.	apply methods for estimating the reliability of new designs, and for analyzing reliability data.

SYLLABUS

EE597 Reliability Engineering

Module I

Introduction: Types of systems, Qualitative and quantitative assessment, Reliability definitions and concepts, Reliability indices and criteria, Reliability evaluation techniques, Reliability improvements, Reliability economics, Reliability monitoring and growth, Basic probability theory**,** Probability concepts, Permutations and combinations, Application in probability evaluation, Practical engineering concepts, Venn diagrams, Rules for combining probabilities, Probability distributions.

(8L)

Module I

Reliability Mathematics: The general reliability function, the exponential distribution, Mean time to failure and repair, series and parallel systems, Markov processes, System reliability using network and state space method.

(8L)

Module III

Network Modeling and Evaluation of Simple and Complex Systems: Service quality criterion, Conditional probability approach, Two-plant single load and two load systems. The probability array for two interconnected systems, Loss of load approach, Interconnection benefits.

(8L)

Module IV

Discrete Markov Chains and Continuous Markov Processes: Introduction toDiscrete Markov chain, Stochastic transitional probability matrix by Discrete Markov chain, Time dependent probability evaluation by Discrete Markov chain**,** Limiting state probability evaluation**,** Absorbing states, Application of discrete Markov techniques, Introduction to Continuous Markov process**,** General modeling concepts, State space diagrams, Stochastic transitional probability matrix by Continuous Markov process , Evaluating limiting state probabilities by Continuous Markov process, Reliability evaluation in repairable systems, Application of techniques to complex systems.

(8L)

Module V

Frequency and Duration Techniques: Frequency and duration concepts, Application to multi-state problems: Two component repairable system, State probabilities, Frequency of encountering individual states**,** Mean duration of individual states, Cycle time between individual states , Frequency of encountering cumulated states**,** Recursive evaluation of cumulative

frequency, Mean duration of cumulated states, Frequency balance approach, Two stage repair and installation process :One component system-no spare available, one spare available, two spares available, one spare available, Limiting number of spares, Application of the techniques.
(8L)

Text Books:

1. Roy Billinton, Ronald N. Allan, "Reliability Evaluation of Engineering Systems Concepts and Techniques", 2nd Edition, Springer Science + Business Media New York 1992.
2. Hoang Pham, "Handbook of Reliability Engineering", Springer 2003.
3. Alessandro Birolini, "Reliability Engineering: Theory and Practice", Springer 1999.

Reference Books:

1. Donald W. Benbow, "The Certified Reliability Engineer Handbook", 2009.

Course Evaluation:
Individual assignment, Theory (Quiz and End semester) examinations

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
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

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

Indirect Assessment

1. Student Feedback on Faculty.
2. 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 Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	-	1
CO2	3	3	2	2	1	1
CO3	3	3	2	2	1	1
CO4	3	3	2	2	1	1
CO5	3	3	2	2	1	1

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between Course Outcomes and Course Delivery Method

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

COURSE INFORMATION SHEET

Course code: EE502
Course title: Advanced Digital Signal Processing Laboratory
Pre-requisite(s): Basics of signals and systems, transform methods, Filter theory.

Credits: 2	L	T	P
	0	0	4

Class schedule per week: 4
Class: M.Tech.
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	enumerate the basic concepts of signals and systems and their interconnections in a simple and easy-to-understand manner through different mathematical operations like folding, shifting, scaling, convolutions, etc. using MATLAB; also gain Knowledge of TMS kit, digital image filter;
2.	construct different realization structures;
3.	determine transfer function and predict frequency response of discrete-time systems by applying various techniques like Z-transform, DFT and FFT using MATLAB;
4.	evaluate cost of filters in terms of memory space complexity, algorithm complexity and economic values;
5.	design and compose digital IIR and FIR filters using filter approximation theory, for optimal cost.

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

CO1	convert analog signal into digital signals and vice-versa, generation of different signals and basic knowledge of TMS kit;
CO2	compute frequency response of the systems using frequency transformation technique, DFT, DIF-FFT or DIT-FFT algorithm, window techniques and visualization using MATLAB;
CO3	design FIR and IIR filters;
CO4	evaluate performance of filter with time variant signals;
CO5	recommend environment-friendly filter for different real- time applications such as optical filter design, acoustic filter design etc.

LIST OF EXPERIMENTS

EE502 Advanced Digital Signal Processing Laboratory

1. Name: Introduction to MATLAB.
Aim: An introduction to MATLAB.

2. **Name: Generation and representation of different types of signal.**
Aim: To perform generation of different signals in MATLAB.

3. **Name: The Z-Transform and Inverse Z-Transform.**
Aim: To write a program to find z-transform of given signal.

4. Name: The Cross-correlation, Auto-correlation between two sequences. Also, Circular convolution between two periodic sequence.
Aim: To perform cross-correlation, auto-correlation and circular convolution of two sequence.

5. **Name:- Discrete Fourier transform and Inverse- Discrete Fourier transform.**
Aim: To write an MATLAB program to find discrete Fourier transform and Inverse- discrete Fourier transform.

6. **Name: DFT by DIT-FFT and DIF-FFT method.**
Aim: To perform DFT by DIT-FFT and DIF-FFT methods in MATLAB.

7. Name: The low pass, high-pass, band-pass and band-stop filter using Butterworth approximation.
Aim: To write a MATLAB program for low pass, high pass and band pass filter using Butterworth approximation.

8. Name: Familiarization with TMS-320C6713 DSP starter Kit.
Aim: To perform a descriptive and practical study for hardware of TMS- 320C6713 DSP starter Kit.

9. Name: Correlation of two discrete time signal.
Aim: To write a MATLAB program to perform correlation of two discrete time signal.

10. **Name: Linear convolution of two sequence using circular matrix method.**
Aim: To write a MATLAB program to perform Linear convolution of two sequence using circular matrix method.

11. Name: The Radix-2 DIT FFT algorithm.
Aim: To perform Radix-2 DIT FFT algorithm of 8-point sequence in MATLAB.

12. **Name: Image Processing.** Aim: 1.To write a program to remove Salt & paper type noise from a given image. 2. To change the colour of specific part of given image. 3. Write a program to remove Gaussian noise from given image.

Books Recommended:

1. Digital signal processing and applications with C6713 and C6416 DSK by RulphChassaing, wiley publication.
2. Real-Time digital signal processing based on the TMS320C6000 by Nasser Kehtarnavaz, ELSEVIER publication
3. DSP applications using C and the TMS320c6x DSK by RulphChassaing, Wiley Publication.

Reference Books:

1. Antonious,Digital Filter Design,Mc-Graw-Hill International Editions.
2. WavelateTransform,S.Rao.
3. WavelateAnalysis:"The scalable structure of Information"Springer2008–Howard L.Resinkoff,RaymondO.Wells

Course Evaluation:

Group project evaluation, Progressive and End semester evaluations

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

1. Visualize different signal processing techniques in real time.
2. Application of real time implementation of digital filter.

POs met through Gaps in the Syllabus:PO5 & PO6

Topics beyond syllabus/Advanced topics/Design:

Adaptive signal processing, Image processing.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

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

Indirect Assessment

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

<u>POs met through Topics beyond syllabus/Advanced topics/Design</u>: PO5 & PO6

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 PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	-	-	-
CO2	3	2	1	2	-	1
CO3	3	1	2	3	-	1
CO4	2	2	2	3	2	2
CO5	2	2	3	1	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

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

COURSE INFORMATION SHEET

Course code: EE504
Course title: Adaptive Control System Lab
Pre-requisite(s): Introduction to System theory, Control theory, Control system design
Co- requisite(s):

Credits: 2	L	T	P
	0	0	4

Class schedule per week: 04
Class: M.Tech.
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	to describe the basic components and various specifications of system;
2.	to explain and interpret the performance of different controllers;
3.	to analyse various techniques in time domain and frequency domain to ensure stability of a system;
4.	to simulate and test them on systems like Inverted Pendulum, Twin Rotor MIMO system (TRMS) and Magnetic Levitation System;
5.	to determine the response of different types of systems using real time workshop in Matlab and appraise their use in real life.

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

CO1	examine performance characteristics of basic components of a system and describe various specifications used for a system;
CO2	explain and interpret the performance characteristics of different sensors, DC motor, ON/OFF and PLC/PID Controllers;
CO3	analyse the effect of addition of poles and zeros in time domain and frequency domain;
CO4	appraise various techniques and analyse stability of a given system;
CO5	simulate and test the techniques on Inverted Pendulum, Twin Rotor MIMO system (TRMS) and Magnetic Levitation System.

LIST OF EXPERIMENTS
EE504 Adaptive Control System Lab

1. To study and implementation of ON-OFF temperature controller.
2. To obtain the step response of first and second order RLC series circuit and determine the value of R and L for a given value of C through time response specification.
3. To obtain Bode plot of the given circuit through experimentation and in term determine the transfer function through by calculations and simulate the same system in Matlab.
4. To obtain the Nyquist plot of the given transfer function and determine the gain margin, phase margin, gain crossover frequency, phase crossover frequency. Comment on the stability.
5. To obtain the characteristics of synchros.
6. To obtain the characteristics of Linear Variable Differential Transformer (LVDT).
7. Study the effect of addition of poles and zeros and correlate the time and frequency domain behavior using MATLAB sisotool for a given system.
8. To study the characteristics of different sensors and transducers.
9. To design a PID controller for a DC motor using Z-N method and verify it in MATLAB.
10. Pole placement design of Inverted pendulum
11. PLC / PID controller based Pressure control using Process trainer kit
12. Study the operation of Twin rotor MIMO system
13. Study the operation of Magnetic Levitation system

Books recommended:

Text Books:

1.M. Gopal, "Control Systems Principles & Design", 2nd Edition, TMH. (T2)
2.K. Ogata, "Discrete Time Control Systems", 2nd Edition, Pearson Education. (T4)

Reference Books:

1.Norman Nise, "Control System Engineering", 4th Edition. (R1)

2.M. Gopal, "Digital Control & State Variable Method", TMH. (R2)
3.B.C. Kuo, "Digital Control System", 2nd Edition, Oxford. (R3)

Course Evaluation:

Individual assignment, Journal, Rough Copy, Regularity and daily viva (Progressive Evaluation), Lab performance and Viva-Voce (End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):
Real time implementation of techniques to meet industry

requirements POs met through Gaps in the Syllabus: **1,2,3,4**

Topics beyond syllabus/Advanced topics/Design:
Experimental verification of Robustness for real time applications

POs met through Topics beyond syllabus/Advanced topics/Design: **1,2,3**

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

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

Indirect Assessment

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

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Self- learning such as use of NPTEL materials and internets
CD5	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	-
CO2	3	3	3	3	2	3
CO3	3	3	3	3	2	-
CO4	3	3	-	3	3	-
CO5	3	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcome	Course Delivery Method
CO1	CD1,CD2,CD4
CO2	CD1,CD2,CD4
CO3	CD1,CD2,CD3,CD4,CD5
CO4	CD1,CD2,CD3,CD4,CD5
CO5	CD1,CD2,CD3,CD4,CD5

Semester II
COURSE INFORMATION SHEET

Course code: EE551
Course title: OPTIMAL CONTROL THEORY
Pre-requisite(s): Fundamentals of Mathematics and Physics, Introduction to System Theory, Control Theory
Co- requisite(s):
Credits: 3 L:3 T:0 P:0
Class schedule per week: 03
Class: M.Tech.
Semester / Level: II/05
Branch: EEE
Name of Teacher:

Course Objectives:

1.	To state the performance index of an Optimal Control System with specific design requirements and design objectives.
2.	To understand the concepts of calculus of variations, Euler Lagrange Equations and apply it to specific real time numerical problems.
3.	To identify and then establish the Hamiltonian and Pontryagin"s formulation from a assumed performance index and apply it to specific real time numerical problems.
4.	To develop methodologies that uses the concept of Finite and Infinite time LQR along with Dynamic Programming procedure to generate control law for a single variable and a multivariable processes subjected to uncertainties.

Course Outcomes:

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

CO1	Identify the design objectives and requirements to set up a performance index for an Optimal Control System.
CO2	Interpret the concepts of calculus of variations to establish Euler Lagrange Equation and apply it to solve some design problems.
CO3	Establish the Hamiltonian and Ponryagin"s formulation from the performance index and apply this concept to develop an optimal control law.
CO4	Develop methodologies to formulate a control law by Pontryagin"s Minimum Principle using Dynamic Programming method and reproduce the results and write effective reports suitable for quality journal and conference publications.
CO5	Develop methodologies to formulate a control law using finite time and infinite time, time varying LQR concepts for regulator and tracking problems and Simultaneously recognize the need to learn, to engage and to adapt in a world of constantly changing technology and play role of team leader or supporter of team.

<u>Syllabus</u>

Module 1: Introduction
Optimization overview, flow chart of linear optimal control technique, Parameter optimization, Minimization problem, Tracking problem, Regulator problem. Calculus of variation. Derivation of Eular-Lagrange equation. The problems of Lagrange, Mayer and Bolza.

(8L)

Module 2: Eular-Lagrange Equation
Application of the Eular-Lagrange Equation to a Linear, first order system, Langrange multiplier, Gradient based unconstrained minimization.

(8L)

Module 3: Hamiltonian Formulation
Formulation of the general nth-order system problem, The Hamiltonian formulation of classical mechanics, Modified Transversality conditions at t = tf.

(8L)

Module 4: Pontryagins maximum principle
Pontryagins maximum principle, Hamilton - Jacobi Equation, Application of variation approach to control problem.

(8L)

Module 5: Optimal LQR Formulation
Quadratic form of performance index; statement of LQR problem, solution of finite time and infinite time regulator problem, solution of Riccati equation, Frequency domain interpretation of LQR design, Stability & robustness properties of LQR design, Linear Quadratic Gaussian (LQG) control. Dynamic Programming: Multistage decision process, Concept of sub-optimization and principle of optimality, Recurrence relationship, computational procedure in dynamic programming.

(8L)

Books recommended:
Text Books:

1. Optimal control system – D.S. Naidu, CRS Press, 2003.
2. Introduction to optimum design – Jasbir S. Vora – Elsevier 2006.
3. Modern Control Theory – J. T. Tou

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

(1) Online optimal control design of controllers.
(2) Interfacing the controllers with the real time physical plants to identify the effects on system‟s performance.

POs met through Gaps in the Syllabus: PO3,PO4

Topics beyond syllabus/Advanced topics/Design

(i) Advanced optimal control design methods for different control problems

POs met through Topics beyond syllabus/Advanced

topics/Design POs met are: PO4

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

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

Indirect Assessment

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

Course Delivery methods

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

Mapping between Course Outcomes and Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	2	2	1
2	3	3	2	2	1	1
3	3	2	2	2	1	1
4	3	3	2	2	2	2

5	3	3	2	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between Course Outcomes and Course Delivery method

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

COURSE INFORMATION SHEET

Course code: EE553
Course title: Nonlinear Control System
Pre-requisite(s): Modern Control Theory
Co- requisite(s): Control system design
Credits: L:3 T:0 P:0
Class schedule per week: 03
Class: M.Tech.
Semester / Level: II/05
Branch: EEE
Name of Teacher:

Course Objectives
This course enables the students to:

1.	Understand nonlinear properties and their types and linearization of nonlinear state differential equation.
2.	Extend comprehensive knowledge of graphical and mathematical analysis of nonlinear physical system for study of stability.
3.	Illustrate basics of different design methods.
4.	Summarize them on regulation and tracking problems.
5.	Validate the design.

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

CO1	List the different types of nonlinear properties.
CO2	Relate an appropriate methodology for analysis of the various types of nonlinearities.
CO3	Organize different methodologies to demonstrate stability of different nonlinear control problems.
CO4	Categorize different techniques like, feedback linearization, sliding mode, gain scheduling to regulation and tracking problems.
CO5	Appraise and compile the different properties and methods of analysis and design for the need of continuous learning in order to create state of art based on advanced mathematical tools.

SYLLABUS

Module – 1: Introduction to Nonlinear system

Types of nonlinearities, Characteristics, Linear approximation of nonlinear systems, Linearization of nonlinear state differential equation, Phase plane analysis: Phase plane representation, Phase portrait, graphical method to obtain phase trajectory, Singular points, Limit cycle.

Module – 2 Describing function analysis

Definition, Derivation of Describing functions for common nonlinear elements, Determination of amplitude and frequency of limit cycle using describing function technique.

[8L]

Module - 3 Lyapunov Theory

Direct method of Liapunov: Introduction, Basic concepts, Stability definitions, Stability theorems, Liapunov functions for nonlinear systems, Methods for determination of Liapunov functions, popov stability criteria.

[8L]

Module – 4 Feedback Linearization

Motivation, Input-output linearization, Full state linearization, State feedback control: Stabilization, Tracking

[8L]

Module – 5. Sliding mode control

Sliding mode control: Sliding mode control: Motivation, Stabilization, Tracking, Regulation via integral control; Gain Scheduling: Scheduling variables; Gain scheduled controller for nonlinear systems.

[8L]

Books Recommended:

1. Slotine & Li, "Applied Nonlinear Control", Prentice Hall, Englewood Cliffs, New Jersey 07632
2. M. Gopal, "Digital Control & State Variable Method", TMH.
3. B. C. Kuo, "Automatic Control System"7th Edition PHI
4. Hassan K. Khalil, "Non Linear Systems", Prentice Hall, Upper Saddle River, NJ 07458

5. S. Banerjee, “Nonlinear Dynamics" (NPTEL Lectures)

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

(1) Practical design of controllers.

(2) Design optimization for industrial projects.

POs met through Gaps in the Syllabus: PO5 & PO6

<u>Topics beyond syllabus/Advanced topics/Design:</u>

Chaos, fractals and solitans

POs met through Topics beyond syllabus/Advanced topics/Design: PO5 & PO6

<u>Course Outcome (CO) Attainment Assessment tools & Evaluation procedure</u>

<u>Direct Assessment</u>

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

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

<u>Indirect Assessment</u>

1. Student Feedback on Faculty
2. 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 OBJECTIVES AND COURSE OUTCOMES

Course Objectives	CO1	CO2	CO3	CO4	CO5
1	3	2	2	2	3
2	3	3	2	2	3
3	3	2	3	3	3
4	3	3	3	3	3
5	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	1	1	1
CO2	3	1	1	3	1	1
CO3	3	1	2	3	1	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

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

COURSE INFORMATION SHEET

Course code: EE555
Course title: Statistical Control Theory
Pre-requisite(s):
Co- requisite(s):
Credits:3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II/05
Branch: EEE
Name of Teacher:

Course Objectives

This course enables the students to:

1.	To describe and classify different types of random variables, random processes, probability density function and cumulative distribution function.
2.	To estimate statistical properties of random variables and random processes such as expected value, variance, standard deviation and correlation functions.
3.	To evaluate autocorrelation functions for given power spectral density, correlate the mean square error of any system with the correlation functions and analyse the response of linear system to random inputs.
4.	To design real time wiener filter, stored data Wiener filter and Kalman filter for any system.

Course Outcomes

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

CO1	Enumerate properties of probability density function, cumulative distribution function, correlation functions and power spectral density of a random process.
CO2	Describe different types of random variable and random processes.
CO3	Calculate expected value, variance, standard deviation and correlation functions of a random variable and random process.
CO4	Analyse the response of linear system to random inputs.
CO5	Design a Wiener and Kalman filter for a system and compare with classical filters.

Syllabus

Module 1: Random Variables

Review of Probability theory. Random experiments. **Random Variables**: Definition. Classification. Cumulative distribution function. Probability density function. Functions of Random Variables. Expected values. Moments. Variance and Standard deviation. Markov and Chebyshev inequalities. Transform methods: Characteristic function; Probability generating function; Laplace transform of the pdf. Transformation of random variable.

(8L)

Module 2:
Multiple Random Variables

Vector random variables. Pairs of random variables. Independence of random variables. Conditional probability and conditional expectation. Multiple random variables. Functions of several random variables. Expected value of function of random variables. Jointly Gaussian random variables. Sums of random variables: Mean; Variance; pdf of sum of random variables. Sample mean and law of large numbers. Central Limit theorem.

(8L)

Module 3:
Random Processes

Definition. Specification: Joint distribution of time samples; Mean; Autocorrelation and Autocovariance functions. Discrete random processes: iid random processes; sum processes: Binomial counting and Random Walk processes. Continuous-time random processes: Poisson processes; Wiener process and Brownian Motion. Stationarity. Time Averaging and Ergodicity, Minimum mean square error filtering: Estimating a random variable with a constant; stored data wiener filter; Real time wiener filter

(8L)

Module 4:
Analysis and Processing of Random signals

Power spectral Density: Continuous and discrete; Power spectral density as a time average. Response of Linear Systems to random signals. Amplitude modulation by random signals. Optimum Linear systems. Estimating the Power spectral density. White noise.

(8L)

Module 5:
Markov Chains

Markov processes. Discrete-time Markov Chains. Continuous-time Markov Chains. Time reversed Markov Chains. Linear stochastic control: LQG problem, Kalman filter and separation principle, Introduction to stochastic differential equations and continuous time stochastic, control: Hamilton-Jacobi-Bellman equation, nonlinear filtering, Minimum variance control .

(8L)

Books Recommended:
Text books:

1. Probability and random Processes for Electrical Engineering- A.Leon-Garcia, Pearson Education

Reference books:

1. Probabaility, Random Variables and Stochastic Processes- A. Papoulis and S. Unnikrishnan Pillai, Fourth Edition, McGraw Hill.
2. Random Signals- Detection, Estimation and Data Analysis, K. Sam Shanmugan & A.M Breipohl, Wiley; 1st Edition (July 1988)

Gaps in the syllabus (to meet Industry/Profession requirements)
Real time applications to meet industry requirements

POs met through Gaps in the Syllabus
1,3,4,5

Topics beyond syllabus/Advanced topics/Design
Simulation given to students as assignments

POs met through Topics beyond syllabus/Advanced topics/Design 1,2,3,4,5,6

Course Outcome (CO) Attainment Assessment tools & Evaluation

procedure Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

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

Indirect Assessment

1. Student Feedback on Faculty
2. 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 of Course Outcomes onto Program Outcomes

Course Outcome	**Program Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
1	3	2	3	3	2	1
2	3	2	3	3	1	1
3	3	3	3	3	3	3
4	3	3	3	3	3	3
5	3	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping of Course Outcomes onto Course Objectives

Course Outcome #	**Course Objectives**			
	1	**2**	**3**	**4**
1	3	3	3	3
2	3	3	1	1
3	3	3	3	3
4	3	3	3	2
5	2	2	2	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between COs and Course Delivery (CD) methods

Course Outcome	**Course Delivery Method**
CO1	CD1,CD2,CD4
CO2	CD1, CD4
CO3	CD1,CD3,CD4, CD5
CO4	CD1,CD2,CD3,CD4, CD5
CO5	CD1,CD2,CD3,CD4, CD5

COURSE INFORMATION SHEET

(ELECTIVE-II)

Course code: EE577
Course title: Control of Electric Drives
Pre-requisite(s): Power electronics and Machine
Co- requisite(s):
Credits:3 L:3 T:0 P:0 C:3
Class schedule per week: 03
Class: M.Tech
Semester / Level: **II/05**
Branch: EEE
Name of Teacher:

Course Objectives

This course enables the students to:

1	Understand different types of electrical drives system.
2	Explanation of working principle of power converters and relate them with different types of drives system
3	Analysis of closed loop control of electrical drives based on power converters.
4	Differentiation between different control strategy of electrical drives in terms of dynamic parameters of system and overall efficiency.
5	Performance evaluation, planning and design procedure for a complex power

Course Outcomes

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

CO1	List different types of electrical drives.
CO2	Associate different types of power converters with different type"s electrical drives. Show suitability of a power converter for a particular application. Solve power management related problems with application of power electronics based topologies.
CO3	Outline shortcomings of each class of conventional drives control strategy and solve them using proper modifications. Identify potential area for power electronics applications.
CO4	Estimate the cost and long term impact of power electronics based drives technology on a large scale project of socio-economic importance.
CO5	Modify existing power electronics based installations. Design new power converter topologies and Plan to develop a power processing unit for a particular requirement in industrial plants as well as domestic applications. Lead or support a team of skilled professionals.

Syllabus

Module1:
Introduction to Electrical Drives:
Drive concepts, different machines & load characteristics, equilibrium and steady state stability, four quadrant operation, referred inertia and load torque for different coupling mechanism, thermal selection of machines

[8L]

Module 2:
DC Motor drives:
Operating limits using armature voltage control and field control techniques, dynamic model (armature voltage control only) of machine and converters (continuous conduction only), open loop dynamic performance, closed loop control using single (speed) and two loops (speed, current), implementation of four quadrant operation. Modelling and control of separately excited dc machine in field weakening region and discontinuous converter conduction mode, design of close loop speed controller for separately excited dc motors.

[8L]

Module 3:
Induction motor drives:
Review of scalar control methods (voltage, constant V/f & frequency) of three phase symmetrical Induction machines, speed control using current controlled VSI drives, close loop speed control with constant v/f control strategy, effects of harmonics and power factor

[8L]

Module 4:
Vector control of Induction machines & Speed control of wound rotor induction machine: Review of vector control, Implementation of direct & indirect vector control schemes, methods of flux estimation, effect of machine parameter variation on vector control performance, speed sensorless control, Direct Torque Control. Static rotor resistance control, static Scherbius Drive using line commutated converter cascade & Cyclo-converter, close loop speed control using slip power recovery, vector control of wound rotor induction machine using Cyclo-converter, introduction to Variable Speed Constant Frequency (VSCF) generation.

[8L]

Module 5:
Control of synchronous machine:
Wound field synchronous machine: Constant volts/Hz control, scalar self-control (commutator less control), vector control. Control of permanent magnet synchronous machine:Brushless DC machine, surface permanent magnet machine.

[8L]

Text Books (T):

1. Fundamental of Electrical Drives: G K Dubey
2. Electric Motor Drives, modelling analysis and control: R Krishnan

Reference Books (R):

1. Modern Power Electronics & Drives: B K Bose

Gaps in the syllabus (to meet Industry/Profession requirements):
Practical implementation of microcontroller based electric drive design.

POs met through Gaps in the Syllabus: PO5

Topics beyond syllabus/Advanced topics/Design
Assignments: Hardware design of closed loop Temperature control using AVR microcontroller

POs met through Topics beyond syllabus/Advanced topics/Design: PO5

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

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

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 Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	2	2	2	1
2	3	3	3	3	2	2
3	3	3	3	3	3	2
4	3	3	3	3	3	3
5	3	3	3	3	3	3

Mapping Between COs and Course Delivery (CD) methods:

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

COURSE INFORMATION SHEET

Course code: EE571
Course title: Soft Computing Techniques in Electrical Engineering
Pre-requisite(s): Basics of signals and systems, Digital Signal Processing, Filter theory.
Credits:3 L:3 T :0 P:0 C:3
Class schedule per week: 3 lectures week
Class :M.Tech
Semester/level: II/05
Branch: Electrical Engineering
Name of Teacher:
Course Objectives:

This course enables the students to:

1.	Understand the basic of Soft Computing Techniques.
2.	Acquainted with the solving methodology of soft computing technique in power systems operation and control.
3.	Analysis of ANN based systems for function approximation in application to load forecasting.
4.	Evaluate fuzzy based systems for load frequency control in power systems.
5.	Design of different problems of optimization in power systems and power electronics.

Course Outcomes:

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

CO1	Identify the soft computing techniques and their roles in building intelligent machines.
CO2	Recognize an appropriate soft computing methodology for an engineering problem.
CO3	Apply fuzzy logic and reasoning to handle uncertainty while solving engineering problems.
CO4	Analysis of neural network and genetic algorithms to combinatorial optimization problems.
CO5	Classify neural networks to pattern classification and regression problems and evaluated its imparts while being able to demonstrate solutions through computer programs.

SYLLABUS

Module - 1

Introduction to Soft Computing: Introduction, Definition of Soft Computing Techniques, Importance of Soft Computing, Main Components of Soft Computing: Fuzzy Logic, Artificial Neural Networks, Introduction to Evolutionary Algorithms, Hybrid Intelligent Systems, Single and multi-objective optimization.

8L

Module –2

Artificial Neural Network and Applications: Introduction, Artificial Neuron Structure, ANN Learning; Back-Propagation Learning, Properties of Neural Networks, Unsupervised learnings, Hopfield networks, Application of GN Models to Electrical Machine Modeling, Short Term Electrical Load Forecasting Using Generalized Neuron Model, Aircraft Landing Control System Using GN Model.

8L

Module - 3

Introduction to Fuzzy Logic and Genetic Algorithm: Introduction, Uncertainty and Information, Types of Uncertainty, Introduction of Fuzzy Logic, Fuzzy Set, Operations on Fuzzy Sets, Fuzzy Intersection, Fuzzy Union, Fuzzy Complement, Fuzzy Concentration, Fuzzy Dilation, Fuzzy Intensification, α-Cuts, Characteristics of Fuzzy Sets, Demorgan‟s Law, Fuzzy Cartesian Product, Various Shapes of Fuzzy Membership Functions, Methods of Defining of Membership Functions, Fuzzy Relation, Defuzzification Methods.Introduction to Genetic Algorithm, Crossover, Mutation, Survival of Fittest, Population Size, Evaluation of Fitness Function.

8L

Module-4

Applications of Fuzzy Rule Based System: Introduction, System‟s Modeling and Simulation Using Fuzzy Logic Approach, Selection of Variables, Normalization Range and Number of Linguistic Values, Selection of Shape of Membership Functions for Each Linguistic Value, Selection of Fuzzy Union and intersection Operators, Selection of Defuzzification Method, Steady State D.C. Machine Model, Transient Model of D.C. Machine, Fuzzy Control System, Power System Stabilizer Using Fuzzy Logic.

8L

Module-5

Applications of Soft Computing Techniques to Electrical Engineering: Applications of Artificial Neural Network, Genetic Algorithms, Fuzzy and Hybrid Systems for Power System Applications: voltage control, voltage stability, Economic load dispatch, Unit commitment, Condition monitoring. Applications of Soft Computing Techniques for Power Electronics and Control Applications.

8L

Text Books:

1. Neural Networks: A Comprehensive Foundation – SimanHaykin, IEEE, Press, MacMillan, N.Y. 1994.
2. S. Rajasekaran, G. A. Vijayalakshmi, Neural Networks, Fuzzy logic and Genetic algorithms, PHI publication.
3. Fuzzy logic with Engineering Applications - Timothy J. Ross, McGraw-Hill International Editions.
4. Fuzzy Sets and Fuzzy logic: Theory and Applications - George J. Klir and Bo. Yuan, Prentice-Hall of India Private Limited.

Reference Books:

1. Chaturvedi, Devendra K, Soft Computing Techniques and its Applications in Electrical Engineering, Hardcover ISBN:- 978-3-540-77480-8, Springer.
2. Kalyanmoy Deb, Optimization for Engineering Design, PHI publication
3. Kalyanmoy Deb, Multi-objective Optimization using Evolutionary Algorithms, Willey Publication
4. Kevin Warwick, Arthur Ekwue, Rag Aggarwal, Artificial intelligence techniques in power systems. IEE Power Engineering Series-22.

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

1. Visualize different soft computing techniques in real time.
2. Hardware implementation of soft computing techniques in real time. POs met through Gaps in the Syllabus:**PO5,PO6**

Topics beyond syllabus/Advanced topics/Design

Soft computing application to image processing, video processing.

POs met through Topics beyond syllabus/Advanced topics/Design:**PO5,PO6**

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 quizzes	30 (3×10)
Assignment(s)	10
Seminar before a committee	10

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

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 PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1			
CO2	3	2	1	2		1
CO3	3	1	2	3		1
CO4	2	2	2	3	2	2
CO5	2	2	3	1	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

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

COURSE INFORMATION SHEET

Course code: EE552
Course title: Control system Design Lab
Pre-requisite(s): Fundamentals of Mathematics and Physics, Introduction to System Theory, Control Theory, Control System Design
Credits: 2 L:0 T:0 P:4
Class schedule per week: 4
Class :M.Tech
Semester/level:II/05
Branch: EEE
Name of Teacher:

Course Objectives

This course enables the students to:

1.	To state the performance characteristics of control systems with specific design requirements and design objectives.
2.	To understand the concepts of PD, PI, PID, lead, lag and lag lead controller design in time domain and frequency domain and apply it to specific real time numerical problems.
3.	To apply the state feedback controller and observer design techniques to modern control problems and analyse the effects on transient and frequency domain response
4.	To realize and then design digital and analog compensators.

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

CO1	Identify the design objectives and requirements of control systems.
C02	Interpret the concepts of PD, PI, PID, lead, lag, lag lead, and discrete data controller design and apply it to solve some design problems.
C03	Apply the state feedback controller design and techniques and outline its effects on system's performance which includes transient response and robustness.
C04	To develop methodologies to design real time digital and analog compensators and

	reproduce the results and write effective reports suitable for quality journal and conference publications.
C05	Aspire for pursuing a carrier in control, recognize the need to learn, toengage and to adapt in a world of constantly changing technology and play role of team leader or supporter of team.

List of Experiments:

1. Design of Servo Position Control
2. Design of PI Controller for a Heating Control System (HCS)
3. Design of a suitable cascade lead, lag, or lag-lead compensator for a given plant
4. Design of a Lead compensator in the frequency domain for a given plant.
5. Design of a Lag-Lead compensator in the frequency domain for a given plant.
6. Design of a State Observer for an undamped oscillator with frequency w_0 for a given plant.
7. Design of a Observer Based State Feedback (OBSF) system for a given system.
8. Design of a compensator (D(z)) in the discrete domain using the root-locus method that meets the following specifications.
9. Design a controller using root-locus, time domain, frequency domain and state space techniques to control the position of motor using only the position measurement in HILINK platform.
10. Design a controller using root-locus, time domain, frequency domain and state space techniques to control the speed of motor using only the speed measurement in HILINK platform.

Books recommended:

Text Books:

1. B.C. Kuo, "Automatic Control System", 7th Edition PHI. (T1)
2. M. Gopal, "Control Systems Principles & Design", 2nd Edition, TMH. (T2)
3. J.G. Truxal, "Automatic Feedback Control System", McGraw Hill, New York. (T3)
4. K. Ogata, "Discrete Time Control Systems", 2nd Edition, Pearson Education. (T4)

Reference Books:

1. Norman Nise, "Control System Engineering", 4th Edition. (R1)
2. M. Gopal, "Digital Control & State Variable Method", TMH. (R2)
3. B.C. Kuo, "Digital Control System", 2nd Edition, Oxford. (R3)
4. Stephanie, “Design of Feedback Control Systems”, 4th Edition, Oxford. (R4)

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

(1) Real time analog design of controllers.
(2) Interfacing the controllers with the real time physical plants to identify the effects on system‟s performance.

POs met through Gaps in the Syllabus

POs met are:

(c) Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
(d) Recognise the need for continuous learning and will prepare oneself to create, select and apply appropriate techniques and modern engineering and IT tools to solve complex control system problems.

Topics beyond syllabus/Advanced topics/Design

(j) Advanced robust design methods for different control problems

POs met through Topics beyond syllabus/Advanced topics/Design

POs met are:

(d) Recognise the need for continuous learning and will prepare oneself to create, select and apply appropriate techniques and modern engineering and IT tools to solve complex control system problems

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

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

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

End Semester Evaluation	% Distribution
Examination Experiment Performance	30
Quiz	10

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

Indirect Assessment

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

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

Mapping between course outcomes and program outcomes

Course Outcome	**Program Outcomes**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
1	3	3	2	1	1	1
2	3	3	2	2	2	1
3	3	3	3	3	2	1
4	3	2	2	3	3	2
5	3	3	2	2	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping between course outcomes and course delivery method

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1,CD2,CD3,CD6
CO3	CD1,CD2,CD3,CD6
CO4	CD1,CD2,CD3,CD6
CO5	CD1,CD2,CD3,CD6

COURSE INFORMATION SHEET

Course code: EE554
Course title: Power Electronics and Drives Laboratory
Pre-requisite(s): Power electronics,
Co- requisite(s):
Credits:2 L:0 T:0 P: 4 C:2
Class schedule per week: 04
Class: M.Tech.
Semester / Level: II/05
Branch: EEE
Name of Teacher:

Course Objective

This course enables the students to:

1.	Understand modeling and control power converters.
2.	Explain PWM techniques for closed loop implementation.
3.	Analyze DPWM techniques and its implementation.
4.	Perform evaluation of close loop electrical drives system.

Course Outcomes

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

CO1	List the different power converters suitable for a given electrical drives application.
CO2.	Apply different control algorithms for power converters applications.
CO3	Analyze performance parameters in time domain and frequency domain.
CO4	Estimate the cost and long-term impact of control of power converters by DPWM on a large scale project of socio-economic importance.
CO5	Modify existing power converter based electrical drives system. Design a new control topology for the control of power converter having superior performance. Lead or support a team of skilled professionals.

List of Experiments:

1. Mathematical Modeling and Experimental validation of state feedback based closed loop control of Boost Converter
2. Mathematical Modeling of Impulse commutated DC-DC chopper
3. Comparative study of Single Pulse PWM, MPWM and SPWM for single phase inverter.
4. Four Quadrant Chopper based 1H.P. DC motor drive with closed loop speed control.
5. Class C-Chopper based 1H.P. DC motor drive open loop speed control
6. Real time flux estimation of three phase induction motor using LabVIEW.
7. Microcontroller (DSPIC) based BLDC motor drive.
8. dSPACE based constant V/F ratio based induction motor drive in closed loop.
9. Mini Project: Mathematical modeling and simulation
10. Mini Project: Hardware implementation

Books recommended:

Text Books (T):

1. P.T. Krein, Elements of Power Electronics. New York: Oxford Univ. Press, 1998.

2. R.W.Erickson and D. Maksimovic, Fundamentals of Power Electronics, 2nd ed . Dordrecht, The Netherlands: Kluwer, 2001.

3. V.Bobal, J.Bohm, and J.Fessl,"Digital Self-Tuning Controllers: Algorithms, Implementation and Applications"1 st Ed.,Springer,2005.
4. Francesco Vasca, Luigi Iannell i,Eds,"Dynamics and Control of Switched Electronic Systems:Advanced

Reference Books (R):
1. Fundamental of Electrical Drives: G K Dubey
2. Electric Motor Drives, modelling analysis and control: R Krishnan
3. Power Electronics: Circuits, Devices, and Applications:MH.Rashid

Gaps in the syllabus (to meet Industry/Profession requirements)
Adaptive Controller implementation in real time.

POs met through Gaps in the Syllabus:PO5

Topics beyond syllabus/Advanced topics/Design
Assignment of FIS based DC motor control system

POs met through Topics beyond syllabus/Advanced topics/Design:PO5

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

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

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

End Semester Evaluation	% Distribution
Examination Experiment Performance	30
Quiz	10

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

Indirect Assessment

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

Course Delivery Methods

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

Mapping Between Course Outcomes And Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	1	1
CO2	3	3	3	3	2	1
C03	3	3	3	3	2	2
CO4	3	3	3	3	3	2
CO5	3	3	3	3	3	3

Mapping between Course Outcomes and Course Delivery Method

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

3rd Semester

Program Core

EC600 Thesis (Part I)   Credit: 8

COURSE INFORMATION SHEET

Course code: EE601
Course title: Process Measurement and Control
Pre-requisite(s):
Co- requisite(s):
Credits: L:3 T:0 P:0
Class schedule per week: 03
Class: MTech
Semester / Level: III
Branch: control/ EEE
Name of Teacher:

Course Objectives
This course enables the students to:

1.	comprehend the advanced control methods used in industries and research.
2.	demonstrate design approach to a class of real and practically significant industrial problems.
3.	analyze design applications in a clear, concise manner
4.	organize basic principles and problems involved in process control and to give look at an overall problem
5.	revise the responses of basic systems that often are the building blocks of a control system.

Course Outcomes

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

CO1.	identify the different type of controller that can be used for specific problems in process industry
CO2.	model several physical systems that can be represented by a first-order and 2nd order transfer function.
CO3.	analyze the actual physical mechanisms,
CO4.	design and tuning of controllers for interacting multivariable systems
CO5	validate and design of digital control systems

SYLLABUS

Module-I:

The general control system, transfer functions, process characteristics.
Concept of feedback and feed forward control system, process measurements- temperature, pressure, flow, level, physical properties - density, viscosity, pH, power, rotational speed.

Module-II:

Final control element, control valves and their characteristics, the controller, proportional integral, proportional integral derivatives controller, pneumatic and hydraulic controller. Servomotor technology in control.

Module-III:

Control system dynamics: transfer function of first order, second order systems. Response of control loop components to forcing functions. Transfer function of feedback control system. Tests for unstable system.

Module-IV:

Advanced control systems: multivariable control problem, ratio control, cascade control, computed variable control, feed forward control, override control, adaptive control.

Module-V:

Application of computer control, on line computer control, servomotor technology in control, brief idea about application of dynamic matrix control, predictive control, Fuzzy logic control.

Books Recommended:

1. "Process Control", F. G. Shinskey, McGraw Hill Book Company.
2. "Process, Modeling, Simulation and Control for Chemical Engineers", W. L. Luyben, McGraw Hill.
3. D.R. Coughanour, 'Process Systems analysis and Control', McGraw-Hill, 2nd Edition, 1991.
4. Coughanouer and Koppel, Process System analysis and Control

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

Concepts of processing plant

POs met through Gaps in the Syllabus: PO5&PO6

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 Marks	25
End Sem Examination Marks	60
Assignment / Quiz (s)	15

Assessment Components	CO1	CO2	CO3	CO4	
Mid Sem Examination Marks					
End Sem Examination Marks					
Assignment					

Indirect Assessment

1. Student Feedback on Faculty
2. 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	Industrial visits/in-plant training
CD8	Self- learning such as use of NPTEL materials and internets
CD9	Simulation

Mapping Between Objectives And Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	**Program Outcomes**											
	1	2	3	4	5	6						
1	3	2	2	-	-	-						
2	2	3	1	2	2	2						
3	3	2	1	2	2	2						
4	2	2	2	2	2	2						
5	2	2	2	2	2	2						

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between COs and Course Delivery (CD) methods

Course Outcomes	**Course Delivery Method**
CO1	CD1,CD2,CD6
CO2	CD1,CD2,CD8,CD9
CO3	CD1,CD2,CD3,CD8
CO4	CD1,CD2,CD3
CO5	CD1,CD2,CD3

COURSE INFORMATION SHEET
(ELECTIVE III)

Course code: EE611
Course title: Physiological Control Systems
Pre-requisite(s): concepts of basic control system
Co- requisite(s):concepts of basic human physiology
Credits: L:3 T:0 P:-0
Class schedule per week: 3
Class: M. Tech
Semester / Level:05
Branch: EEE
Name of Teacher:

Course Objectives

This course enables the students:

A.	Introduction to the physiological concepts and mathematical tools that they will need to understand and analyse these physiological control systems.
B.	Structures and mechanisms responsible for the proper functioning of these systems.
C.	Explaining how these complex systems operate in a healthy human body
D.	Use linear control theory to model and analyse biological systems

Course Outcomes

After the completion of this course, students will be:

1.	Understanding of different physiological system
2.	Abel to model and simulate
3.	Can designed a control strategy
4.	Identification of complex control system
5.	Design the physiological system.

SYLLABUS

Module-1: Introduction: Systems Analysis, Physiological Control Systems Analysis, Differences between Engineering and Physiological Control Systems, Mathematical Modeling: Generalized System Properties, Models with Combinations of System Elements, Linear Models of Physiological Systems, Distributed-Parameter versus Lumped Parameter Models, Linear Systems and the Superposition Principle,

Module-2: Static Analysis of Physiological Systems: Open-Loop versus Closed-Loop Systems, Determination of the Steady-State Operating Point, closed and open loop Regulation of Cardiac Output, Regulation of Glucose, Chemical Regulation of Ventilation, The Gas Exchanger, The Respiratory Controller, Closed-Loop Analysis: Lungs and Controller Combined.

Module-3: Time-Domain Analysis of Linear Control Systems: Linearized Respiratory Mechanics: Open Loop versus Closed-Loop, Open-Loop and Closed-Loop Transient Responses: First and second-Order Model, Impulse Response, Step Response, Open-Loop versus Closed-Loop Transient Responses, Reduction of the Effects of External Disturbances, Reduction of the Effects of Parameter Variations, Integral Control, Derivative Feedback, Transient Response Analysis, Frequency Response of a Model of Circulatory ontrol, requency Response of the Model, Frequency Response of Glucose-Insulin Regulation.

Module-4: Stability Analysis: Model of Cheyne-Stokes BreathinCO2 Exchange in the Lungs Transport Delays Contents Controller Responses Loop Transfer Functions

Module-5: Nonlinear Analysis of Physiological Control Systems Nonlinear versus Linear Closed-Loop Systems Phase-Plane Analysis Local Stability: Singular Points Method of Isoclines Nonlinear Oscillators Limit Cycles The van der Pol Oscillator Modeling Cardiac Dysrhythmias The Describing Function Method Methodology Application: Periodic Breathing with Apnea Models of Neuronal Dynamics Hodgkin-Huxley Mode The Bonhoeffer-van der Pol Model.

Text books:

Reference books: 1. Physiological Control Systems by M. C. K. Khoo, PHI, 2001

Gaps in the syllabus (to meet Industry/Profession requirements)
Concept of human anatomy & physiology

POs met through Gaps in the Syllabus: PO5&PO6

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 Marks	25
End SemExamination Marks	60
Assignment / Quiz (s)	15

Assessment Compoents	**CO1**	**CO2**	**CO3**	**CO4**	
Mid Sem Examination Marks					
End Sem Examination Marks					
Assignment					

Indirect Assessment –

1. Student Feedback on Faculty
2. 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	Industrial visits/in-plant training
CD8	Self- learning such as use of NPTEL materials and internets
CD9	Simulation

MAPPING BETWEEN OBJECTIVES AND OUTCOMES

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	1	2	3	4	5	6						
1	3	2	2	-	-	-						
2	2	3	1	2	2	2						
3	3	2	1	2	2	2						
4	2	2	2	2	2	2						
5	2	2	2	1	2	2						

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COS AND COURSE DELIVERY (CD) METHODS

Course Outcomes	Course Delivery Method
CO1	CD1,CD2,CD6
CO2	CD1,CD2,CD8,CD9
CO3	CD1,CD2,CD3,CD8
CO4	CD1,CD2,CD3
CO5	CD1,CD2,CD3

COURSE INFORMATION SHEET

Course code: EE602
Course title: Advanced Control System Design Lab
Pre-requisite(s): Mathematics, Statistics, Introduction to System Theory, Control Theory, Control System Design, Optimal Control Theory
Co- requisite(s):
Credits: 2 L:0 T: 0 P: 4
Class schedule per week: 04
Class: M. Tech.
Semester / Level: III/06
Branch: EEE
Name of Teacher:

Course Objectives

This course enables the students:

A.	To define and explain regulators, observers, LQR/LQG based optimal controllers used in control system
B.	To illustrate and explain the applications of regulators, observers, LQR/LQG based optimal controllers
C.	To analyse stability of a given system and recommend best controller for different applications
D.	To appraise regulators, observers, LQR/LQG based optimal controllers and Kalman filter

Course Outcomes

After the completion of this course, students will be:

1.	describe regulators, observers, LQR/LQG based optimal controllers used in control system
2.	explain the applications of regulators, observers, LQR/LQG based optimal controllers
3.	modelling and simulation of regulators, observers, LQR/LQG based optimal controllers and nonlinear systems
4.	investigate stability of a given system for varying gain and recommend best controller for different applications
5.	Design regulators, observers, LQR/LQG based optimal controllers and Kalman filter

List of Experiments:

1. Design a regulator for an inverted pendulum on a moving cart to achieve certain specifications.
2. Design a pole placement regulator and full order observer for a plant.
3. Design a Kalman filter.
4. Design a LQG and LQR based optimal controller.
5. Simulation of nonlinear function
6. Control of twin rotor MIMO system (TRMS) (Feedback Instruments)
7. Modelling and control of magnetic levitation system (Feedback Instruments)
8. To investigate the effects of gain on stability of the system (DC motor)
9. To find the best response of a system (DC motor) using PID controller

10. To determine the open loop transfer function of a DC motor

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

Real time applications to meet industry requirements

POs met through Gaps in the Syllabus

1,2,3,4

Topics beyond syllabus/Advanced topics/Design

Given some design problems suitable for industry needs to solve in a group

POs met through Topics beyond syllabus/Advanced topics/Design

1,2,3,4,6

Course Delivery methods	
Lecture by use of boards/LCD projectors	CD1
Tutorials/Assignments	CD2
Seminars	CD3
Self- learning such as use of NPTEL materials and internets	CD4
Simulation	CD5

Mapping of lab experiment with Course Outcomes

Experiment	**Course Outcomes**				
	1	**2**	**3**	**4**	**5**
1	H	H	H		H
2	H	H	H		H
3					H
4	H	H	H		H
5			H		
6			H	H	
7			H	H	
8				H	
9				H	
10				H	

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Contribution during CO Assessment**
3 quizes	30(3x10)
Assignment	10
Seminar before a committee	10

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

Indirect Assessment –

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

MAPPING BETWEEN OBJECTIVES AND OUTCOMES

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	**Program Outcomes**					
	a	b	c	d	e	f
1	3	3	3	3	3	
2	3	3	3	3	2	3
3	3	3	3	3	2	
4	3	3		3	3	
5	3	3	3	3	3	3

<34%=1, 34-66%=2, 66-100%=3

MAPPING OF COURSE OUTCOMES ONTO COURSE OBJECTIVES

Course Outcome #	**Course Objectives**			
	A	**B**	**C**	**D**
1	3	3	3	3
2	3	3	3	2
3	2	2	3	2
4	2	2	3	
5	1	2	2	3

<34%=1, 34-66%=2, 66-100%=3

MAPPING BETWEEN COS AND COURSE DELIVERY (CD) METHODS

Course Outcome	**Course Delivery Method**
CO1	CD1,CD4,CD5
CO2	CD1, CD4, CD5
CO3	CD1, CD2, CD3, CD4, CD5
CO4	CD1, CD2, CD4, CD5
CO5	CD1, CD2, CD4, CD5

4th Semester

Program Core

EC650 Thesis (Part II) Credit: 16