Department of Electrical and Electronics Engineering

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

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. programmes 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 centre 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.

Programme 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)

GA 1: Scholarship of Knowledge

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

GA 2: Critical Thinking

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

GA 3: 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.

GA 4: 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.

GA 5: 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.

GA 6: 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.

GA 7: 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.

GA 8: 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.

GA 9: 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.

GA 10: 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.

GA 11: 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

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

PO2: An ability 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.

Course Structure & Syllabus

Postgraduate Programme

(Control Systems)

Department of Electrical & Electronics Engg.

Birla Institute of Technology

Mesra, Ranchi-835215

Course Structure

Program: Master of Engineering

(Control Systems)

Electrical & Electronics Engineering

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
Proposed Course Structure of ME (Electrical Engineering) Programme

Control Systems Specialization

I Semester

Sr. No.	CODE	Subject	L	T	P	C
1.	MEE 1103	Advanced Digital Signal Processing	3	-	-	3
2.	MEE 1101	Modern Control Theory	3	1	-	4
3.	MEE 1119	Control System Design	3	-	-	3
4.	MEE 1105	Optimization in Engineering Design (A***pplied Sciences Paper***)	3	-	-	3
5.		Elective – I	3	-	-	3
6.	MEE 1104	Digital Signal Processing Laboratory	-	-	3	2
7.	MEE 1102	Control System Laboratory	-	-	3	2

Total Credit : 20

II Semester

Sr. No.	CODE	Subject	L	T	P	C
1.	MEE 2101	Soft Computing Techniques *	3	1	-	4
2.	MEE 2123	Nonlinear Control Systems	3	-	-	3
3.	MEE 2125	Stochastic Processes	3	-	-	3
4.		Appropriate Free Electives from other Departments	3			3
5.		Elective - II	3	-	-	3
6.	MEE 2124	Advanced Control System Laboratory	-	-	3	2
7.	MEE 2158	Power Electronics and Drives Laboratory	-	-	3	2

Total Credit : 20

III Semester

Sr. No.	Subject	L	T	P	C
1.	MEE 3101 Thesis	-	-	-	15

IV Semester

Sr. No.	Subject	L	T	P	C
1.	MEE 3101 Thesis	-	-	-	20

List of Elective - I

Sr. No.	CODE	Subject	L	T	P	C
1.	MEE 1117	Optimal Control Theory	3	-	-	3
2.	MEE 1109	Robust Control Systems	3	-	-	3
3.	MEE 1107	Pattern Recognition	3	-	-	3
4.	MEE 1111	Estimation and Identification Techniques	3	-	-	3
5.	MEE 1113	Robotics and Artificial Intelligence	3	-	-	3

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI

Proposed Course Structure of ME (Electrical Engineering)

List of Elective -II

Sr. No.	CODE	Subject	L	T	P	C
1.	MEE 2121	Systems Biology	3	-	-	3
2.	MEE 2117	Microprocessor Application	3	-	-	3
3.	MEE 2115	Embedded System and Applications	3	-	-	3

Semester 1

Course code: MEE 1103

Course title: Advanced Digital Signal Processing

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

Class schedule per week: 3 classes per week

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.

Syllabus:

Module - 1

Introduction: Discrete time systems, Discrete time signals, Analysis of discrete-time linear time invariant systems, Difference equation description.

Module - 2

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.

Module - 3

Frequency domain analysis, Discrete Fourier transform (DFT), Properties of DFT, Inverse DFT, Inter relationship with z-transform and Hilbert-transforms, Discrete Hilbert transform, FFT algorithms- Decimation in time and decimation in frequency.

Module – 4

Filter function approximation and transforms: Review of approximation of ideal analog filter response. IIR filter: Designs based on analog filter approximation impulse invariant, Bilinear transformation, Direct design of IIR filters, Time domain design techniques. Butterworth, Chebyshev type I & II, Elliptical filters.

Module - 5

Properties and design of FIR filters: Properties, Design techniques - window technique, Frequency sampling comparison of IIR and FIR filters.

Module - 6

Multirate digital signal processing, Introduction, Decimation by factor D, I sampling rate conversion by a rational factor I/D.

Module - 7

Introduction to continuous discrete and fast wavelet transforms. Families of Wavelets: orthogonal and bi-orthogonal wavelets, Daubechies' family of wavelets in detail.

Course Outcomes:

At the end of the course, student will be able to-

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

Text Books:

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.
3. Raghuveer M. Rao, Ajit S. Bopardikar, "Wavelet Transforms: An Introduction.

Reference Books:

1. Antonious, Digital Filter Design, Mc-Graw-Hill International Editions.
2. Wavelate Transform, S. Rao.
3. Wavelate Analysis: "The scalable structure of Information" Springer 2008 – Howard L.Resinkoff, Raymond O. Wells.

Course code: MEE 1101

Course title: Modern Control Theory

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

Class schedule per week: 4 classes per week

Course Objectives:

1. To state students with concepts of state variables;
2. To extend comprehensive knowledge of mathematical modeling of physical system;
3. To illustrate basics of deigning a control problem;
4. To summarize them on theory of model control theory.

Syllabus:

1. **Introduction:**

   Systems, modelling, analysis and control, continuous-time and discrete-time.

2. **State Variable Descriptions:**

   Introduction, concept of state, state equations for dynamic systems, state diagrams.

3. **Physical Systems & State Assignments:**

   Linear continuous-time and discrete-time models; non-linear models; local linearization of non-linear-model.

4. **Solution of State Equations:**

   Existence and uniqueness of solution, linear time-invariant continuous-time state equations, linear discrete-time state equations.

5. **Controllability & Observability:**

   Concept of controllability & observability, controllability and observability tests for continuous -time systems, controllability and observability of discrete-time systems, canonical forms of state models.

6. **State models and input-output descriptions:**

   Input-output maps from state model and vice-versa, transfer matrix, output controllability, reducibility.

7. **Model Control**

Introduction, Effect of state feedback on controllability and observability, pole placement by state feedback; Full order observers, Reduced-order observers; deadbeat control by state feedback, deadbeat observers.

8. **Fractional Order Controller**

Fractional order calculus, Fractional order transfer function modelling, Frequency domain analysis of fractional order controller, Time domain analysis of time domain controller.

Course Outcomes:

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

1. apply the different ways of modeling of physical system and read basics of the theory of fractional order controller;
2. recommend linearization of a nonlinear system;
3. summarize the controllability & observability conditions;
4. explain the functionality of Model Control;
5. formulate potential design techniques from analysis.

Books Recommended:

1. Digital Control & State Variable Methods – M. Gopal, Tata Macgraw Hill.
2. Modern Control System Theory by M. Gopal, New Age International(P) Ltd., 2nd edition.
3. Linear Systems by Thomas Kailath, Prentice-Hall Inc.,1980.
4. Modern Control Engg. by K. Ogata, Pearson, 5th edition

Course code: MEE 1119

Course title: Control System Design

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

Class schedule per week: 3 classes per week

Course Objectives:

Objective of this course is to provide students with:

i. To state the performance characteristics of control systems with specific design requirements and design objectives;
ii. 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
iii. To apply the state feedback controller and observer design techniques to modern control problems and analyze the effects on transient and frequency domain response;
iv. To realize and then design digital and analog compensators.

Syllabus:

Module 1:
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.

Module 2:
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.

Module 3:
Design with lag/lead/lag-lead 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.

Module 4:
Forward & feed-forward controller, minor loop feedback control, concept of robust design for control system, pole-zero cancellation design.

Module 5:
Sate feedback control, pole placement design through state feedback, state feedback with integral control, design state observer.

Module 6:
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.

Module 7:
Hardware and Software Implementation of Common Compensator: Physical realization of common compensator with active and passive elements, tunable PID algorithms- position and velocity algorithms.

Course Outcomes:

At the end of the course, student will be able to-

i. draw the impedance and reactance diagram and can explain different components modelling for load flow, short circuit, contingency analysis and harmonic analysis of power system.

ii. explain and solve load flow problems by different methods .

iii. identify and analyze the different abnormal (fault) conditions in power system utilizing efficient computer algorithm.

iv. explain different factors affecting the power system security for single and multiple contingencies.

v. explain different numerical methods for state estimation of power system.

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)

Course code: MEE1105

Course title: Optimization in Engineering Design

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

Class schedule per week: 3 classes per week

Course Objectives:

Objective of this course is to provide students with:

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.

Syllabus:

Module – 1

INTRODUCTION

Optimal problem formulation, Design variables constraints, Objective function, Variable bounds, Engineering optimization problems, Optimization algorithms.

Module - 2

ONE-DIMENSIONAL SEARCH METHODS

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.

Module - 3

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

Module - 4

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.

Module - 5

MULTIVARIABLE OPTIMIZATION ALGORITHM

Optimality criteria, Unidirectional search, Direct search methods: Simplex search method, Hooke-Jeeves pattern search method.

Module - 6

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.

Module - 7

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.

Course Outcomes:

At the end of the course, the student will be able to:

1. Have a basic understanding of traditional and non-traditional optimization algorithms.
2. Formulate engineering design problems as mathematical optimization problems.
3. Use mathematical software for the solution of engineering problems.
4. Differentiate the various optimization concepts and equivalently apply them to engineering problems.
5. Evaluate pros and cons for different optimization techniques.

Referred Books:

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. Hadle.

Elective-I:

Course code: MEE 1117

Course title: Optimal Control Theory

Credits:	L	T	P	C
	3	0	0	3

Class schedule per week: 3 classes per week

Course Objectives:

i. To state the performance index of an Optimal Control System with specific design requirements and design objectives;
ii. To understand the concepts of calculus of variations, Euler Lagrange Equations and apply it to specific real time numerical problems
iii. 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
iv. 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.

Syllabus:

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.

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

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

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

Module 5:
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.

Module 6:
Dynamic Programming: Multistage decision process, Concept of sub-optimization and principle of optimality, Recurrence relationship, computational procedure in dynamic programming.

Module 7:
Adaptive Control System: Adaptive Controllers, Identifications, Decision making, Modification, Application, Classification: Passive, Active, Dynamic Adaptive Control Systems, Adaptive PI controller for D.C. drive, learning machine.

Course Outcomes:

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

i. Identify the design objectives and requirements to set up a performance index for an Optimal Control System;
ii. Interpret the concepts of calculus of variations to establish Euler Lagrange Equation and apply it to solve some design problems;
iii. Establish the Hamiltonian and Ponryagin's formulation from the performance index and apply this concept to develop an optimal control law;
iv. 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 ;
v. 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.

Books recommended:

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

Course code: MEE 1113

Course title: Robotics and Artificial Intelligence

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

Class schedule per week: 3 classes per week

Course Objectives:

This course enables the students:

A. To explain the characteristics of robots, discuss different types of sensors and basic programming languages used for robotics

B. To relate direct and inverse kinematics problem of robots and apply methods to solve them and to use techniques for planning robot motions.

C. To explain different methods for control of robotic manipulators.

D. To recommend the use of robotic vision in different applications of robots.

Syllabus:

Module 1:
Introduction of Robotics: Evolution of Robots and Robotics. What is and what is not a robot. Robot classification. Robot specifications. Robot applications. Direct Kinematics: Coordinate frames; Rotations; Homogeneous coordinates; D-H representation; The Arm Equation.

Module 2:
Inverse Kinematics: Inverse kinematics problem, General properties of solutions, Tool configuration, Robotic work cell, Robot Arm Dynamics: Lagrange-Euler formulation; Newton Euler formulation; Generalized D'Alembert equation.

Module 3:
Workspace Trajectory and Trajectory Planning: Workspace analysis. Workspace envelope. Workspace fixtures. Pick and place operation. Continuous-path motion. Interpolated motion. Straight line motion.

Module 4:
Control of Robot Manipulators: Computed torque control; Near Minimum time control; Variable structure control; Non-Linear decoupled feedback control; Resolved motion and Adaptive control.

Module 5:
Robotic Sensors: Different sensors in robotics: Range; Proximity; Touch; Torque; Force and others.

Module 6:

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

Module 7:

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.

Course Outcomes:

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

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

Books Recommended:

1. Fundamental of Robotics: Analysis and Control- Robert J. Schilling.
2. Robotics: Control , Sensing ,Vision and Intelligence- K.S. Fu, R.C. Gonzalez and Lee.
3. Robotics and Control – R. K. Mittal and I. J. Nagrath.

Course code: MEE 1109

Course title: Robust Control Systems

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

Class schedule per week: 3 classes per week

Syllabus:

Introduction to Robust Control

Modeling, Uncertainty and Robustness, Co-prime factorization, System Stabilities, Sensitivity function, General regulator problem, Small-gain theorem

Norms

Norms of signals, Norms of systems, Relation between signals and systems norm, Computing 2 and ∞ norms, Multivariable norms.

Robustness Concepts

Internal stability, Plant uncertainty, parametric uncertainty, unstructured uncertainty, Linear fractional transformation, Robust stability, Robust performance

H_∞ Design

Mixed sensitivity problem, Augmentation of weighting functions, H_∞ solution, 2 degree of freedom H_∞ design, Optimal H_2 controller design, Loop shaping design procedure.

μ Analysis and Synthesis

Structured singular values, μ –Analysis, consideration of robust performance, D-K iteration method and μ-K iteration method.

Lower order controller design

Balanced truncation method, Singular perturbation approximation, Hankel norm approximation, Reduction via fractional factors.

Robust Control Case studies

Robust control design problems for: inverted pendulum, spring mass damper, Distillation column, electrical drives, aerospace systems.

Recommended Books:

- J.C. Doyle, B.A. Francis, A.R. Tannenbaum, Feedback Control Theory, McMillan Publ., New York 1992.
- D.W. Gu, P. Hr Petkov and M.M. Konstantinov, Robust Control Design with MATLAB, Springer Verlag London Limited, 2005.
- S. Skogestad, I. Postelthwaite, Multivariable Feedback Control Analysis and Design. Second Edition. Wiley, chichester, UK, paperback [0-470-01168-8]

Course code: MEE 1107

Course title: Pattern Recognition

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

Class schedule per week: 3 classes per week

Syllabus:

Module - I
Basics of pattern recognition : Overview of pattern recognition, Pattern Recognition Systems, Classification and Description, Pattterns and Feature Extraction, Training and Learning methods, Pattern Recognition approaches.

Module - II
Bayesian decision theory : Classifiers, Discriminant functions, Decision surfaces, Normal density and discriminant functions, Discrete features, Parameter estimation methods, Maximum-Likelihood estimation, Gaussian mixture models, Expectation-maximization method, Bayesian estimation

Module - III
Hidden Markov models for sequential pattern classification : Discrete hidden Markov models, Continuous density hidden Markov models, Dimension reduction methods, Fisher discriminant analysis, Principal component analysis

Module - IV
Non-parametric techniques for density estimation : Parzen-window method, K-Nearest Neighbour method

Module - V
Linear discriminant function based classifiers : Perceptron, Support vector machines, Multi category Generalization

Module - VI
Non-metric methods for pattern classification : Non-numeric data or nominal data, Decision trees

Module - VII
Unsupervised learning and clustering :Criterion functions for clustering, Algorithms for clustering: K-means, Hierarchical and other methods, Cluster validation

Text Books:

1. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001

Reference Books:

1. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009.
2. C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006

Course code: MEE 1111

Course title: Estimation and Identification Techniques

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

Class schedule per week: 3 classes per week

Course Objectives:-

This course enables the students to:

1. Visualize the difference between prediction and identification and enumerate different specifications used in the identification of system.
2. Describe the design of parameter for modelling of dynamic system.
3. Compute the system identification using adaptive technique.
4. Illustrate the concepts of extended Kalman filter and enumerate the concept of estimation theory in both discrete and continuous-line.

Syllabus:

Module – 1
Introduction - Definition of project, purpose, scope, project implementation and cost estimation, Economic operation, State estimation, Security assessment.

Module - 2
Fundamentals of random signals, Spectral estimation, Optimum (Wiener and Kalman) linear estimation, Estimation of scalar signals, Scalar Wiener filter, Scalar Kalman filter, Estimation of vector signals, Vector Kalman filter, Prediction.

Module – 3
Introduction to parameter estimation, Least squares and regression models. Least squares estimation, Recursive computation, Finite impulse response (FIR) models, Transfer function models, Probabilistic models for sensors and systems, Probabilistic estimation methods, Linear Kalman filter, Extended Kalman filter and their use in sensor-based estimation problems.

Module - 4
Estimation Theory: Discrete Line - Baye's theorem, Orthogonal projection Kemma, Prospectics of the minimum variance filters (Kalman filter), Linear exponential Gaussion estimation, Worst ease filter design, Extended Kalman filter, Modified gain extended Kalman filter.

Module - 5
Estimation Theory: Continuous-line - Continuous-line Kalman filter, Properties of Kalman filter (EKF), Linear minimum variance filter.

Module – 6

Linear quadratic optimal control, Non-linear systems, System identification, Non-parametric model identification, Correlation and spectral methods, Considerations in practical application.

Module - 7

Concept of adaptive control, Definitions, Types of adaptivity, Effects of process variation, Control essentials, Ratio of adaptive control and adaptive systems, Determination of adaptation gain, Design of Model Reference Adaptive Systems (MRAS) using Lyapunov theory, Relation between Model Reference Adaptive Systems (MRAS) and Self-Tuning Regulators (STR), Basic approaches and solutions, Transient of disturbances and modelling errors.

Course Outcomes:

At the end of the course, student will be able to-

1. Examine the performance of basic components of a system and can able to describe various specifications used in the identification of system.
2. Explain and interpret the design of parametric model of a system.
3. Solve the system identification using adaptive technique.
4. Apply the concepts of extended Kalman filter, modified gain extended Kalman filter for system identification.
5. Understand the concept of estimation theory: continuous-line Kalman filter, properties of Kalman filter, linear minimum variance filter.

Books Recommended:

1. Optimization, Estimation and Control - A.E. Bryson & Y.C. Ho
2. Applied Optimal Estimation - A. Gelb, NIT Press, Cambridge
3. Optimal Estimation, Identification and Control - RCK Lee, NIT Press, Combridge, Massachusetts, 1964.
4. Stochastic Optimal Linear Estimation and Control - J.S. Meditch, McGraw Hill, N.Y., 1969.

Course code: MEE1104

Course title: Digital Signal Processing Lab

Credit:	**L**	**T**	**P**	**C**
	0	0	3	2

Class schedule per week: 3 classes per week

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. Design and compose digital IIR and FIR filters using filter approximation theory, frequency transformation techniques, window techniques in MATLAB environment.

List of Experiments:

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 color of specific part of given image
    3. Write a program to remove Gaussian noise from given image

Course Outcomes:

At the end of the course, student will be able to-

1. Convert analog signal into digital signals and vice-versa, generation of different signals and basic knowledge of TMS kit.
2. Examine system response using Z-transform, convolution methods and interpret transfer function of the selected system;
3. Evaluate frequency response of the systems using frequency transformation technique, DFT, DIF-FFT or DIT-FFT algorithm, window techniques and visualization using MATLAB;
4. Design FIR and IIR filters.
5. Recommend environment-friendly filter for different real- time applications such as optical filter design, acoustic filter design etc.

Text Books:

1. Digital signal processing and applications with C6713 and C6416 DSK by Rulph Chassaing, Wiley publication.
2. Real-Time digital signal processing based on the TMS320C6000 by Nasser Kehtarnavaz, ELSEVIER publication.

Reference Books:

1. Antonious, Digital Filter Design, Mc-Graw-Hill International Editions.
2. Wavelate Transform, S. Rao.
3. Wavelate Analysis: “The scalable structure of Information” Springer 2008 – Howard L. Resinkoff, Raymond O. Wells

Course code: MEE 1102

Course title: Control System Laboratory

Credit:	**L**	**T**	**P**	**C**
	0	0	3	2

Class schedule per week: 3 classes per week

Course Objectives:

This course enables the students to:

A. To describe the basic components and various specifications of system

B. To explain and interpret the performance of different controllers

C. To analyse various techniques in time domain and frequency domain to ensure stability of a system.

D. To simulate and test them on Inverted Pendulum, Twin Rotor MIMO system (TRMS) and Magnetic Levitation System

List of Experiments:

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 draw the 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. Study of analogue 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

Course Outcomes:

At the end of the course, student will be able to-

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

Books Recommended:

1. Digital Control & State Variable Methods – M. Gopal, Tata Macgraw Hill.
2. Modern Control System Theory by M. Gopal, New Age International(P) Ltd., 2nd edition.
3. Linear Systems by Thomas Kailath, Prentice-Hall Inc.,1980.
4. Modern Control Engg. by K. Ogata, Pearson, 5th edition

Semester: 2

Course code: MEE 2101

Course title: Soft Computing Techniques

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

Class schedule per week: 4 classes per week

Course Objectives:

The course objective is to provide students with an ability to:

1. Conceptualize neural networks and its learning methods.
2. Infer the basics of genetic algorithms and their applications in optimization and planning.
3. Interpret the ideas of fuzzy sets, fuzzy logic and fuzzy inference system.
4. Categorize the tools and techniques available for soft computing, while employing them according to practical requirements of an engineering design.

Syllabus

Module - I

Introduction: Background, uncertainty and imprecision, statistics and random processes, uncertainty in Information. Fuzzy sets and membership, chance versus ambiguity, fuzzy control from an industrial perspective, Knowledge based systems for process control, knowledge based controllers, knowledge representation in knowledge based controllers.

Module – II

Mathematics of Fuzzy Control : Classical sets, Fuzzy sets, Properties of fuzzy sets, operations on fuzzy sets. Classical relations and fuzzy relations - cartesian product, crisp relation, Fuzzy relations, Tolerance and Equivalence Relations, Fuzzy tolerance and equivalence relations, operation on fuzzy relations, The extension principle.

Module - III

Membership Function: Features of membership functions, standard forms and boundaries, Fuzzyification, Membership value assignment. Fuzzy-to-Crisp conversions: Lambda-cuts for fuzzy sets, Lambda-cuts for fuzzy relations. Defuzzification Methods

Module – IV

Introduction: Structure and foundation of Single Neuron, Neural Net Architectures, Neural Learning Application, Evaluation of Networks, Implementation. Supervised Learning - Single Layer Networks, Perceptions, Linear saparability, Perception, Training algorithms, Guarantee of success, Modifications.

Module – V

Multilayer Networks - Multilevel discrimination, preliminaries, backpropagation algorithm, setting the parameter values, Accelerating the learning process, Applications, RBF Network.

Module - VI

Unsupervised learnings - Winner take all networks, learning vector quantizers, ART, Topologically organised networks.

Associative Models - Non-iterative procedures for Association, Hopfield networks,

Module - VII

Discussion of Neural Networks and Fuzzy Logic Application in areas of Power Electronics and motor control.

Course Outcomes:

At the end of the course, the student will be able to :

1. Identify the soft computing techniques and their roles in building intelligent machines.
2. Recognize an appropriate soft computing methodology for an engineering problem.3.
3. Apply fuzzy logic and reasoning to handle uncertainty while solving engineering problems.
4. Apply neural network and genetic algorithms to combinatorial optimization problems;
5. Classify neural networks to pattern classification and regression problems and evaluvate its imparts while being able to demonstrate solutions through computer programs.

Text Books:

1. Fuzzy logic with Engineering Applications - Timothy J. Ross, McGraw-Hill International Editions.
2. Fuzzy Sets and Fuzzy logic: Theory and Applications - George J. Klir and Bo. Yuan, Prentice- Hall of India Private Limited.
3. Neural Networks: A Comprehensive Foundation – Siman Haykin, IEEE, Press, MacMillan, N.Y. 1994.

Reference Books:

1. Elements of Artificial Neural Networks – Kishan Mehrotra, Chilakuri K. Mohan, Sanjay Ranka (Penram International Publishing (India)

Course code: MEE 2123

Course title: Nonlinear Control Systems

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

Class schedule per week: 3 classes per week

Course Objectives:

i. To state students with concepts of nonlinear properties and their types and linearization of nonlinear state differential equation
ii. To extend comprehensive knowledge of graphical and mathematical analysis of nonlinear physical system for study of stability;
iii. To illustrate basics of different design methods;
iv. To summarize them on regulation and tracking problems.

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.

Module - 3 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.

Module – 4 Chaos, fractals and solitans: Introduction, Modelling of dynamical systems: Differential equations and difference equations. Stable, unstable and chaotic systems, Chaos in feedback systems, Types of attractions: Point, periodic, quasiperiodic and strange attractors. Pathways to chaos, Geometry of fractals, Chaotic dynamics on fractals, Characterization of attractors from experimental data

Module – 5 Feedback Linearization: Motivation, Input-output linearization, Full state linearization, State feedback control: Stabilization, Tracking.

Module – 6 Sliding mode control: Sliding mode control: Sliding mode control: Motivation, Stabilization, Tracking, Regulation via integral control.

Module – 7 Gain Scheduling: Scheduling variables, Gain scheduled controller, Gain scheduled PI controller, Modification of gain scheduled controller, Development of a gain scheduled tracking controller for nonlinear systems.

Course Outcomes:

At the end of the course, student will be able to:

I. List the different types of nonlinear properties
II. Relate an appropriate methodology for analysis of the various types of nonlinearities.
III. Organize different methodologies to demonstrate stability of different nonlinear control problems.
IV. Categorize different techniques like, feedback linearization, sliding mode, gain scheduling to regulation and tracking problems.
V. 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.

Books Recommended:

1. B. C. Kuo, “Automatic Control System” 7th Edition PHI.
2. M. Gopal, “Digital Control & State Variable Method”, TMH.
3. S. Banerjee, “Nonlinear Dynamics”.
4. Slotine, “Nonlinear Control Systems”.
5. Hassan K. Khalil, “Non Linear Systems”.

Course code: MEE 2125

Course title: Stochastic Processes

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

Class schedule per week: 3 classes per week

Course Objectives:

This course enables the students :

A. To describe and classify different types of random variables, random processes, probability density function and cumulative distribution function

B. To estimate statistical properties of random variables and random processes such as expected value, variance, standard deviation and correlation functions.

C. 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.

D. To design real time wiener filter, stored data Wiener filter and Kalman filter for any system.

Syllabus:

Module 1:
Introduction: Probability models in Electrical engineering. Basic concepts of Probability theory. Random experiments. Axioms of probability. Conditional probability. Independence of events. Sequential experiments.

Module 2:
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. Testing a fit of a distribution to data Transform methods: Characteristic function; Probability generating function; Laplace transform of the pdf. Transformation of random variable.

Module 3:
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.

Module 4:
Sums of Random Variables and Long-term averages: Sums of random variables: Mean;Variance; pdf of sum of random variables. Sample mean and law of large numbers.

Central Limit theorem. Minimum mean square error filtering: Estimating a random variable with a constant; stored data wiener filter; Real time wiener filter.

Module 5:

Random Processes: Definition. Specification: Joint distribution of time samples; Mean; Autocorrelation and Auto covariance functions. Discrete random processes: iid random processes; sum processes: Binomial counting and Random Walk processes. Continuous-time random processes: Poisson processes; Processes derived from Poisson processes; Wiener process and Brownian Motion. Stationarity. Time Averaging and Ergodicity

Module 6:

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. Kalman Filter Estimating the Power spectral density. White noise.

Module 7:

Markov Chains: Markov processes. Discrete-time Markov Chains. Continuous-time Markov Chains. Time reversed Markov Chains.

Course Outcomes:

At the end of the course, student will be able to-

1. enumerate properties of probability density function, cumulative distribution function, correlation functions and power spectral density of a random process
2. describe different types of random variable and random processes
3. calculate expected value, variance, standard deviation and correlation functions of a random variable and random process.
4. analyse the response of linear system to random inputs.
5. design a Wiener and Kalman filter for a system and compare with classical filters

Books Recommended:

Text Book:

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

Reference Books:

1. Probabaility, Random Variables and Stochastic Processes- A. Papoulis & S. U. Pillai.
2. Random Signals- K. Sam Shanmugan & A.M Breipohl.

Elective II:

Course code: MEE 2115

Course title: Embedded Systems & Applications

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

Class schedule per week: 3 classes per week

Course Objectives:

The course objective is to provide students with an ability to :

1. comprehend the basic functions, structure, concept and definition of embedded systems;
2. interpret ATMEGA8 microcontroller, FPGA & CPLD, TMS320C6713 processors in the development of embedded systems;
3. correlate different serial interfacing protocols(SPI,TWI,I2C,USART);
4. understand interfacing of different peripherals(ADC,DAC,LCD,motors).

.

Syllabus:

MODULE – I

Introduction: Embedded Systems Overview, Processor technology- General purpose processors (Software), Single purpose processors (Hardware), Application- Specific processors; IC Technology- Full-custom/VLSI, Semicustom ASIC (Gate Array and standard cell), PLD, etc.

MODULE – II

Basic Concepts of Computer Architecture: Concepts, Memory, Input/Output, DMA, Parallel and Distributed computers, Embedded Computer Architecture, etc.

MODULE – III

Embedded Processors & Systems: Atmel AVR ATMEGA 8 Micro-controller: Introduction, Major features, Architecture, Application and programming. Timers/Counters, ADC, USART, SPI, TWI, Vectored Interrupts.

MODULE – IV

FPGA: Xilinx XC3S400 FPGA Architecture, XC9572 CPLD Architecture, VHDL Programming (VHDL Synthesis)

MODULE – V

dsp-based controllers: Texas Instrument’s TMS320C6713 DSP processor: Introduction, Major features, Architecture, Application and programming.

MODULE – VI & VII

Peripherals and Interfacing: Adding Peripherals and Interfacing- Serial Peripherals and Interfacing- Serial Peripheral Interface (SPI), Inter Integrated Circuit (I^2C), Adding a Real-Time Clock with I^2C, Adding a Small Display with I^2C; Serial Ports - UARTs, RS-232C & RS-422, Infrared Communication, USB, Networks- RS-485, Controller Area Network (CAN), Ethernet, Analog Sensors - Interfacing External ADC, Temperature Sensor, Light Sensor, Accelerometer, Pressure Sensors, Magnetic - Field Sensor, DAC, PWM; Embedded System Applications - Motor Control, and Switching Big Loads.

Course Outcomes:

At the end of the course, the student will be able to :

1. visualize the basic elements and functions of ATMEGA8 and FPGA/CPLD in building an embedded system;
2. work with modern hardware/software tools(Xilinx project navigator for synthesis of VHDL codes) for building prototypes of embedded systems;
3. interface various sensors, ADC, DAC, LCD, stepper motors with FPGA/CPLD and ATMEGA8;
4. employ various bus protocols like SPI,TWI,I2C for interfacing peripherals;
5. apply design methodologies for embedded systems, while appreciating the considerations for embedded systems design: specification, technological choice, development process, technical, economic, environmental and manufacturing constraints, reliability, security and safety, power and performance

Text Books:

1. Catsoulis, John, "Designing Embedded Hardware", First/Second Edition, Shroff Publishers & Distributors Pvt. Ltd., New Delhi, India.
2. Vahid, Frank and Givargis, Tony, "Embedded System Design - A Unified hardware/Software Introduction", John Wiley & Sons, (Asia) Pvt Ltd., Replika Press Pvt., Delhi - 110040.
3. Douglas Perry, “VHDL Programming by Example”, TMH publication
4. J. Bhaskar, “A VHDL Primer”, Pearson Education
5. Mazidi&Mazidi, "AVR Microcontrollers", Pearson Education
6. RulphChassaing, “Digital Signal Processing and Applications with C6713 and C6416 DSK”, John Wiley and Sons publication.

Reference Books:

1. Stuart R. Ball, “Embedded Microprocessor Systems, Real World Design”, Second Edition, Newnes publication.
2. Nasser Kehtarnavaz, “Real Time Digital Signal Processing based on the TMS320C6000”, Elsevier publication.

Course code: MEE 2121

Course title: Systems Biology

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

Class schedule per week: 3 classes per week

Syllabus:

Module I: Introduction

1. A Basic Principles, Modelling Natural Systems, Differential Equations, Dynamic Systems Theory, Dealing with uncertainty, The System Biology approach, Cell Chemistry, Model behavior, Typical aspects of Biological Systems and corresponding models.
2. Biology in Nutshell: The origin of life, Molecular Biology of the cell, Major classes of Biological Molecules, Structural Cell Biology, Expression of Genes, Cell cycle.

Module II: Biochemical Reactions

1. Enzyme kinetics and Thermodynamics, The ODE Approach, Biochemical reaction modeling, Fundamental quantities and definitions, Basic principles and assumptions, Elementary reactions, Complex reactions, Parallel reactions, Autocatalytic reactions.
2. Mathematical representation of Reconstructed Networks: Basic features of Stoichiometric Matrix, Topological properties, Fundamental subspaces of S, The (Right) Null Space of S, The left Null space of S, row and column spaces of S.

Module III: Dynamic systems Approach

1. Pathways as Dynamic Systems, The Rote of Feedback, Phase-plane Analysis Nonlinear Dynamics.

Module IV: Stochastic Modelling and Simulation.

Introduction, Mass action models the average of CME? Stochastic Simulation, AN ODE to Differential Equations, Steady Sate Solution for the master equation, Temporal evolution of average and variance, Generating functions, summary.

Module V: Dynamic Modelling of Biochemical Networks

Michaeles-Menten modelling, Multinomial Systems, S-System, The Heinrich model MAP Kinase (MAPK) Pathway, The Ras/Raf/MEK/ERK Pathway, Feedback and Oscillations in Signaling pathways.

Module VI: Modules and Control Mechanisms:

Linear Module, Hyperbolic Model, Sigmoid Module, Robust or Adaptive Module, Feedback Systems.

Module VII: Modelling of Gen Expression

Modules of Gen Expression, Promoter identification, Modelling specific Processes in Eukaryotic Gen Expression. Modelling the expression of operons in E.Coli.

Books Recommended :

1. Systems Biology Dynamic Pathway Modeling – Olaf Wolkenhauer
2. System Biology Practice, Concepts, Implementation and Application by E. Klipp, R. Herwing, A. Konald, C. Wierling, H. Lehrach.
3. Systems Biology Properties of Reconstructed Networks – Bernhard O. Palsson

Course Code : MEE 2117

Course Title : Microprocessor Application

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

Class schedule per week: 3 classes per week

Syllabus:

Module - 1 & 2
Intel 8086μp family architecture - namely Intel 8086/8088, 80186, 286, 386 Microprocessors. Instruction Enhancements, Addressing Modes, Concepts of segmentation, Real and virtual addressing.

Module - 3
Assembly language programming using 8086 μp for application oriented implementation. Use of MASM, assembler directives, Assembling, Linking programmes, Use of MACROS and conditional assembly, Program implementation and measurement of execution time. Use of BIOS ROM and DOS functions for program development.

Module - 4 & 5
Input/output operations using standard peripheral devices, 8255 and its modes, Interrupts, Interrupt driven processing, handshaking operation, Relay switching etc., applications using serial I/O using 8251 for asynchronous/synchronous communication, 8254 timer, 8237 DMA controller, and 8259 priority interrupt controller etc., interface chips.

Module - 6
A/D and D/A converters, types, speed of operation, execution speeds, Data Acquisition Applications.

Module - 7
DOS function calls, and writing application oriented programs for I/O control of Machines, Systems and Status.

Books Recommended:

1. Liu, Yu - Cheng and Gibson, Glenn. A., "Microcomputer Systems: The 8086 Family", Prentice-Hall of India Pvt. Ltd., New Delhi, India.
2. Gaonkar, Ramesh S., "Microprocessor, Architecture, Programming and Applications with 8085/8080 A", New Age International Pvt. Ltd., New Delhi, India.
3. Douglas V. Hall, "Microprocessors and Interfacing - Programming and Hardware", Tata McGraw-Hill Publishing Company Ltd., New Delhi, India.
4. Miller, Alan R, “Assembly Language Techniques for the IBM PC”, BPB Publications New Delhi, India.

Course Code : MEE 2124

Course Title : Advanced Control System Laboratory

Credits:	**L**	**T**	**P**	**C**
	3	0	0	2

Class schedule per week: 3 classes per week

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

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)
7. Modelling and control of magnetic levitation system
8. To investigate the effects of gain on stability of the system
9. To find the best response of a system using PID controller
10. To determine the open loop transfer function of a motor

Course Outcomes:

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

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

Books Recommended:

1. Digital Control & State Variable Methods – M. Gopal, Tata Macgraw Hill.
2. Modern Control System Theory by M. Gopal, New Age International(P) Ltd., 2nd edition.
3. Linear Systems by Thomas Kailath, Prentice-Hall Inc.,1980.
4. Modern Control Engg. by K. Ogata, Pearson, 5th edition

Course Code : MEE 2158

Course Title : Power Electronics and Drives Laboratory

Credits:	**L**	**T**	**P**	**C**
	3	0	0	2

Class schedule per week: 3 classes per week

Course Objectives:

This course enables the students:

1. To impart basic concept of converter and inverter for drives operation.
2. To provide skills for application of appropriate tools in order to solve various technical problems related to speed regulation.
3. To encourage students to undertake technical projects of in the field of electrical drives nature.
4. To provide knowledge current state of art in the field of power electronics and electrical drives in order to motivate students to take up research activities.

List of Experiments:

1. Execute a suitable test on a given Power MOSFET in order to observe its o/p and transfer characteristics.
2. Do a suitable test on a TRIAC based AC voltage controller in order to determine its voltage harmonic factor.
3. Do a suitable experiment to determine and observe characteristics of impulse commutated chopper.
4. Do a test & observe the characteristics of modified series inverter.
5. Do a test on 4 Quadrant DC-DC chopper in order to observe working of DC motor drive.
6. Execute an experiment in order to investigate V/F control of induction motor.
7. Do a suitable test in order to observe operation of fully SCR controlled rectifier based DC motor drive.
8. Perform appropriate experiment on DC servomotor for its angular control.
9. Group Project (Mathematical Modeling and Simulation)
10. Group Project (Hardware implementation)

Course Outcomes

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

6. Explain basic operating principle of various control system components, converters and inverters for drives application.
7. Analyze the performance parameter of various controllers, converters in the application of control of electric drives.
8. Select appropriate tools for design and up gradation work to solve complex engineering problem
9. Undertake design projects involving inter disciplinary nature in the domain of electrical drives and power electronics.

10. Provide capability to work in a team consisting of members from different areas of expertise and pursue research in order to find new innovative solution for various social and economic problems using technical rationale.

Books Recommended:

1. Fundamental of Electrical Drives: G K Dubey
2. Modern Power Electronics & Drives: B K Bose - Electric Motor Drives, modeling analysis and control: R Krishnan