SAVITRIBAI PHULE PUNE UNIVERSITY

FACULTY OF ENGINEERING

SYLLABUS FOR
M.E. ELECTRICAL (CONTROL SYSTEMS)
(2017 course)

WITH EFFECT FROM YEAR 2017-2018

STRUCTURE FOR M.E. (ELECTRICAL) CONTROL SYSTEMS 2017 COURSE

SEMESTER I

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Lect./Pr	Paper		TW	Oral / presentation	Total	
			In Semester Assessment	End Semester Assessment				
503101	Optimization Techniques in Control System	4	50	50	--	--	100	4
503102	Automation in Manufacturing	4	50	50	--	--	100	4
503103	Non Linear Control System	4	50	50	--	--	100	4
503104	Research Methodology	4	50	50	--	--	100	4
503105	Elective I	5	50	50	--	--	100	5
503106	Lab Practice I	4	--	--	50	50	100	4
Total		**25**	**250**	**250**	**50**	**50**	**600**	**25**

SEMESTER II

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Lect./Pr	Paper		TW	Oral/presentation	Total	
			In Semester Assessment	End Semester Assessment				
503107	Multivariable and Optimal Control System	4	50	50	--	--	100	4
503108	Control of Power Electronic Circuits	4	50	50	--	--	100	4
503109	Digital Signal Processing and its Applications	4	50	50	--	--	100	4
503110	Elective II	5	50	50	--	--	100	5
503111	Lab Practice II	4	--	--	50	50	100	4
503112	Seminar I	4	--	--	50	50	100	4
Total		**25**	**200**	**200**	**100**	**100**	**600**	**25**

SEMESTER III

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Lect./ Pr	Paper		TW	Oral/presentation	Total	
			In Semester Assessment	End Semester Assessment				
603101	Advanced Drives and Control	4	50	50	--	--	100	4
603102	System Identification and Adaptive Control	4	50	50	--	--	100	4
603103	Elective III	5	50	50	--	--	100	5
603104	Seminar II	4	--	--	50	50	100	4
603105	Project Stage I	8	--	--	50	50	100	8
Total		**25**	**150**	**150**	**100**	**100**	**500**	**25**

SEMESTER IV

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME				CREDITS
		Lect./ Pr	Paper	TW	Oral/presentation	Total	
603106	Seminar III	5	--	50	50	100	5
603107	Project Stage II	20	--	150	50	200	20
Total		**25**	**--**	**200**	**100**	**300**	**25**

Evaluation of Seminars and Project in different semesters would be carried out as per rules and regulations of ME programs under faculty of engineering effective from June 2017.

LIST OF ELECTIVE SUBJECTS

Note: Select any one subject from Module I and one subject from Module II for each Elective.

503105: Elective-I (5 Credits)		**503110: Elective-II (5 Credits)**		**603103: Elective-III (5 Credits)**	
Module I (Credits=4)	Module II (Credit=1)	Module I (Credits=4)	Module II (Credit=1)	Module I (Credits=4)	Module II (Credit=1)
i) Automation and Robotics	i) Project Management	i) Robust Control Systems	i) Electric Vehicles	i) Intelligent Control	i) Artificial Intelligent tools
ii) Modeling of Dynamic System	ii) IPR and Patent Law	ii) Large Scale Systems	ii) Fundamentals of Cyber Security	ii) SCADA Systems and Applications	ii) Intelligent Sensors and instrument-ation
iii) Industrial Automation and control	iii) Technical communication	iii) Advanced Digital Control Techniques	iii) Disaster management	iii) Computer Aided Control System Design	iii) Human Rights
--	iv) Smart Grid Technologies	--	iv) Communi-cation protocols in SCADA System	--	iv) Green building design
--	v) Signal Processing of Power Quality Disturbances	--	v) Mechatronics	--	v) MEMS and Applications

EXAMINATION SCHEME GUIDELINES

A) Compulsory Subjects: Credits 4

Total Marks: 100

To be done at Institute Level		**University Exam**	
In Semester Assessment Units I to IV		**End Semester Assessment**	
Class Tests	30 Marks	Units I to IV	18 Marks
Assignments / Mini Project	20 Marks	Unit V	16 Marks
		Unit VI	16 Marks
Total Marks	**50 Marks**	**Total Marks**	**50 Marks**

B) Elective Subjects: Credits 5

Total Marks: 100

Module I (Credits – 4)			
In SemesterAssessment Units I to IV		**End Semester Assessment**	
Class Tests	15 Marks	Units I andII	12 Marks
Assignments/PPT presentation	10 Marks	Units III andIV	14 Marks
		Unit V	12 Marks
		Unit VI	12 Marks
Total Marks	**25 Marks**	**Total Marks**	**50 Marks**

Module II (Credit – 1)	
In Semester Assessment Units I and II	
Class Tests / Assignments	25 Marks
Total Marks	**25 Marks**

Board of Studies
Electrical Engineering

Semester I

503101: OPTIMIZATION TECHNIQUES IN CONTROL SYSTEM

Teaching Scheme:
Theory: 4Hrs/Week
Credits: 4

Examination Scheme:
In-Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks

Prerequisites: Formulation and solution of mathematical models in management, economics, engineering and science applications in which one seeks to minimize or maximize anobjective function, General theory and approaches for solving optimization problems, Numerical algorithms for constrained optimization problems in engineering and sciences.

Course Objectives: Course objectives are to
- ✓ Understand and apply optimization techniques to solve industrial operations
- ✓ Study and examine effect of different optimization techniques for same problem

Course Outcomes: Upon successful completion of this course, the student will be able to
- ✓ Identify the optimization of resources and apply techniques to industrial problems
- ✓ Predict the life time of replacement items
- ✓ Ascertain the optimal sequence to do the jobs through the machines and CPM and PERT Network models
- ✓ Know the goal of inventory control
- ✓ Employ the concept of Transportation and assignment problems

Unit I: Mathematical Concepts
Review of extrema of functions, real valued function, partial derivatives gradient vector, Taylor series, Directional derivatives, direction of steepest descent, local and global extrema, unimodal function, limitations of method of differential calculus, unconstrained extrema of differentiable functions, constrained extrema, method of Lagrange multipliers.

(8 Hrs.)

Unit II: Optimization and Classical Techniques
Engineering applications of optimization, optimization problem, classification of optimization problems and techniques, single variable, multivariable optimization with no constraints, equality constraints, inequality constraints unconstrained minimization, steepest descent method, conjugate gradient method, Newton's method.

(8 Hrs.)

Unit III: Linear Programming
Linear programming problems, LP problems, involving LE constraints, simplex method, revised simplex method, duality.

(8 Hrs.)

Unit IV: Nonlinear Programming

One dimensional minimization method, unimodel function, elimination methods, dichotomous search, Fibonacci method, Golden section method, interpolation methods, unconstrained optimization technique.

(8 Hrs.)

Unit V: Dynamic Programming

Multistage decision process, sub optimization and principle of optimality, computational and calculus method of solution, final value and initial value problems dynamic programming in continuous time systems.

(8 Hrs.)

Unit VI: Integer and Stochastic Programming

Integer and stochastic programming, zero-one programming, mixed integers, integer linear programming, graphical representation, Gomory cut method, Integer nonlinear programming, and polynomial. Stochastic linear programming, nonlinear programming and dynamic programming.

(8 Hrs.)

Text Books:

1. "Optimization Theory and Applications", S. S. Rao, New Age International Publications.

Reference Books:

1. "Optimization Methods in Operations and Research Systems Analysis", K. V. Mital and C. Mohan, New Age International Publications.

2. "Optimization Concepts and Applications in Engineering", A. D. Belegundu and T. R. Chandrupatla, Pearson Education.

503102: AUTOMATION IN MANUFACTURING

Teaching Scheme:
Theory: 4Hrs/Week
Credits: 4

Examination Scheme:
In-Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks

Prerequisites: Microprocessors, microcontrollers and its programming, PLC programming, significance of PID, basic blocs of control system and their functions

Course Objectives: Course objectives are to

- ✓ Learn use of data acquisition using various devices and utilize it for programming to measure and control system variables
- ✓ Make aware of drives and system employed in the industrial automation
- ✓ Understand the concepts of cyber physical systems, trends in digital manufacturing and idea of industry 4.0

Course Outcomes: Upon successful completion of this course, the student will be able to

- ✓ List sensors and devices used in the industrial automation and explain their use for interfacing, sensing and measurement of variables.
- ✓ Identify various drives and explain its operation when used in the industrial automation.
- ✓ Distinguish Hydraulic and pneumatic systems employed in industrial automation.
- ✓ Explain characteristics of cyber physical systems
- ✓ Describe overview of digital manufacturing with operation mode and architecture
- ✓ Portray main idea of Industry 4.0

Unit I: Sensors and Devices

Data conversion devices, sensors, microsensors, transducers, signal processing devices, relays, contactors and timers. Microprocessors controllers and PLCs. Description of PID controllers.

(8 Hrs.)

Unit II: Drives

Drives: stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, and transfer systems.

(8 Hrs.)

Unit III: Hydraulic and Pneumatic Systems

Hydraulic systems: flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps.

Pneumatics: production, distribution and conditioning of compressed air, system components and graphic representations. (8 Hrs.)

Unit IV: Cyber Physical Systems

Cyber physical systems: Introduction, features, Analysis of representative domains in cyber physical systems. Dynamical systems: Continuous time models, linear systems designing controller analysis technique

(8 Hrs.)

Unit V: Digital Manufacturing

Introduction, Concept, research and development status of digital manufacturing, Connotation and research methods, Operation mode and architecture of digital manufacturing systems, Modelling theory and method of digital manufacturing science, theory system of digital manufacturing science. Computing manufacturing methodology.

(8 Hrs.)

Unit V: Industry 4.0

Introduction, Drivers of Industry 4.0, Changing market demand, new technological possibilities, Main idea of industry 4.0, phases of industrial development, industry 4.0: fourth industrial revolution, central features of the concept, economical potential, End to end Digital integration within smart factory, flexibility and adaptability, current technological solutions, paradigm shift in production logistics.

(8 Hrs.)

Reference Books:

1. Boltan, W., Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Longman, Singapore, 1999.
2. HMT Ltd. Mechatronics, Tata McGraw□Hill, New Delhi, 1988.
3. Joji, P., Pneumatic Controls, Wiley (India), 2008.
4. Waller, D. and Werner H., Hydraulics Workbook Basic Level, Festo Didactic Gmbh& Co., Germany, 2001.
5. Principles of Cyber-Physical Systems, Rajeev Alur, MIT Press London
6. Fundamentals of Digital Manufacturing Science ,Zude Zhou, Shane ShengquanXie, Dejun Chen, Springer
7. Industry 4.0: The Industrial Internet of Things, Alasdair Gilchrist, Apress
8. Big Data in Cyber-Physical Systems, Digital Manufacturing and Industry 4.0, Lidong Wanga, GuanghuiWangb, International Journal Engineering and Manufacturing, 2016, 4, 1-8

503103: NON LINEAR CONTROL SYSTEMS

Teaching Scheme:
Theory: 4Hrs/Week
Credits: 4

Examination Scheme:
In-Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks

Prerequisite: Linear system, State space analysis.

Course Objectives: Course objectives are to

- ✓ Classify different types of nonlinearity and it’s characteristics
- ✓ Make use of study of various methods to analyze and design of nonlinear system
- ✓ Study various methods of linearization
- ✓ Study sliding mode control and implement it in designing control system

Course outcomes: Upon successful completion of this course, the student will be able to

- ✓ Identify different types of characteristics of nonlinear system
- ✓ Apply various methods to analyze nonlinear system
- ✓ Classify and make use of study of nonlinear system in implementing for design
- ✓ Identify and develop linearization methods
- ✓ Apply knowledge of sliding mode control
- ✓ Solve problems related to nonlinear system

Unit I: Introduction to Non Linear System

Classification of non-linarites, types of non-linearity in physical system, Peculiarities of nonlinear systems, methods of analysis of non-linear systems and comparison. (8 Hrs.)

Phase Plane Analysis

Concept of phase plane, singular points, phase trajectory, phase portraits, methods of plotting phase plane trajectories Vander Pol’s equation, stability from phase portrait, time response from trajectories, Isocline method, Delta method of phase trajectory construction, MATLAB Simulation. (8 Hrs.)

Unit II: Describing Function Method

Describing function, DF of typical nonlinearities, stability analysis using DF method, pole zero shifting transformation, Circle criterion, Popov criterion. (8 Hrs.)

Unit III: Lyapunov Stability

Autonomous Systems: Stability of equilibrium point. Concepts of positive definite/semi definite, negative definite/ semi definite, indefinite functions, Lyapunov function Lyapunov Stability: asymptotic stability, global asymptotic stability. (8 Hrs.)

Unit IV: Stability Criterion

Linearization of nonlinear systems about equilibrium point, Methods of construction of Liapunov functions, Liapunov's direct method. Stability analysis of nonlinear system using Liapunov's theorems. (8 Hrs.)

Unit V: Sliding Mode Control

Feedback linearization, Input Output linearization, Concept of variable structure control, SMC, properties of SMC, reachability condition, η-reachability, reaching laws, computation of control, chattering phenomenon. (8 Hrs.)

Unit VI: Design of Sliding Mode Control

Nonlinear control system design using SMC, effect of disturbance, matched and unmatched uncertainty (8 Hrs.)

Text Books:

- Automatic Control System: George J. Thaler Brown, JaicoPublications
- Nonlinear Systems: Hasan A. Khalil, Prentice Hall of India
- Spurgeaon and Edwards, “Sliding Mode Control Theory and Applications”.

Reference Books:

- Control Systems Theory and Application: SamarjitGhosh, PearsonEducation
- Principle and Design of Control Systems, M. Gopal. Tata McGraw-Hill Education,2002
- Introduction to Control Engineering: A. K. MandaI, New Age InternationalPublications
- Nonlinear Systems: Analysis, Stability & Control, S.S. Sastry, Springer Verlag, New York, 1999.

503104: RESEARCH METHODOLOGY

Teaching Scheme:
Theory: 4Hrs/Week
Credits: 4

Examination Scheme:
In-Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks

Prerequisite: Determinants and their Properties. Matrices, Types of Matrices, Algebraic Operations on Matrices, Transpose of a Matrix, Symmetric and Skew Symmetric Matrices, Elementary Operation (Transformation) of a Matrix, Minors and Cofactors of matrices, Adjoint and Inverse of a Matrix. Vector Algebra, Types of Vectors, Addition of Vectors, Multiplication of a Vector by a Scalar, Scalar and Vector Products of Vectors.

Course Objectives: Course objectives are to
- ✓ Give knowledge about basic concepts in research
- ✓ Train students for technical writing
- ✓ Cultivate quality research output
- ✓ Learn about matrices, determinants, applications to solve linear system of equations, matrix factorization, eigenvalues and eigenvectors.
- ✓ Cover relevant applications in engineering to illustrate the utility of learning these topics.
- ✓ Use mathematical software, in problem solving, to allow the solution of more complex problems and provide visualization of the same.

Course Outcomes: Upon successful completion of this course, the student will be able to
- ✓ Carry out literature review and write it in proper format.
- ✓ Enlist different parts of thesis and research proposal.
- ✓ Find research metrics and information about patents from web.
- ✓ Use the techniques and theory of linear algebra to model various real world problems.
- ✓ Apply system of linear equations in solving the problems of electrical engineering, chemical engineering, applied mechanics etc.
- ✓ Employ eigenvalues and eigenvector in Control theory, electric circuits, advanced dynamics and mechanics.

Unit I: Basics of research
Definition, Research Characteristics, Research Need, Objectives and types of research: Motivation and objectives – Research methods vs Methodology, Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical. Research Formulation, Defining and formulating the research problem, Selecting the problem Necessity of defining the problem, Importance of literature review in defining a problem. Using web for literature review, Types of literature: books, papers, reviews, treatise, monographs, patents, process of identifying gap areas from literature review Development of working hypothesis. Different tools for literature survey. [8Hrs]

Unit II: Technical Writing:
Writing Thesis: Structure and components of scientific reports, Types of report – Technical reports and thesis, Significance, Different steps in the preparation , Layout, structure and Language of typical reports.

Writing papers: types of technical papers, Journal papers, Conference papers, Survey papers, Poster papers, Comparison, Structure of a survey, conference and journal paper.

Writing Research Proposal: Importance of research funding in research, standard formats for different research schemes of AICTE, DST. Preparation for research proposal, how to write a research proposal. . [8Hrs]

Unit III: Assessment of research output:
Measure for quality of research, citation index Researcher metrics (i10-index, H-index etc.), Article metrics, Journal Metrics.
Ethical practices in research such as plagiarism, acknowledgment etc. Commercialization of research, Copy right, royalty, Intellectual property rights and patent law, Trade related aspects of Intellectual Property Rights, patent search,drafting and filing patent, legal procedure in granting patent.
` [8Hrs]

Unit IV: Fields, Vectors and Vector Spaces
Fields, Vectors, Vector spaces, Subspaces, Linear combinations and subspaces spanned by a set of vectors, Linear dependence and Linear independence,
[8 Hrs.]

Unit V: Solution of Linear Algebraic Equations
Simple systems, Homogeneous and Non-homogeneous systems, Gaussian elimination, Null Space and Range, Rank and nullity, Consistency conditions in terms of rank, General Solution of a linear system, Elementary Row and Column operations, Row Reduced Form, Triangular Matrix Factorization
[8 Hrs.]

Unit VI: Eigenvalues and Eigenvectors
Eigenvalue – Eigenvector pairs, characteristic equation, Algebraic multiplicity, Eigenvectors, Diagonal Form and Jordan form of Matrix representation, use of software to solve the examples.
[8 Hrs.]

Reference Books:

1. Louis Cohen, Lawrence Manion and Keith Morrison, Research Methods in Education, 7th Edition, Cambridge University Press, ISBN – 978-0415-58336-7
2. Anthony, M., Graziano, A.M. and Raulin, M.L., Research Methods: A Process of Inquiry, Allyn and Bacon
3. Ranjit Kumar, Research Methodology: A Step by Step Guide for Beginners, 2nd Edition, APH Publishing Corporation
4. Leedy, P.D. and Ormrod, J.E., Practical Research: Planning and Design, Prentice Hall

5. Fink, A., Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
6. Leslie Lamport, ' Latex: A document preparation system' Addison Wesley, Reading, Massachusetts, second edition, 1994, ISBN 0-201-52983-1.
7. Introduction to Linear Algebra with Application, Jim Defranza, Daniel Gagliardi, Tata McGraw-Hill Elementary Linear Algebra, Applications version, Anton and Rorres, Wiley India Edition.
8. Elementary Linear Algebra, Ron Larson, Cengage Learning
9. Linear Algebra and its Applications, David C. Lay, Pearson Education

Text Books:

1. Kothari, C.R., Research Methodology: Methods and Techniques. New Age International
2. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., An introduction to Research Methodology, RBSA Publishers
3. Suresh Sinha, Anil K Dhiman,Research Methodology, ESS Publications,Volumes 2
4. Day R.A., How to Write and Publish a Scientific Paper, Cambridge University Press
5. Wadehra, B.L. Law relating to patents, Trade Marks, copyright designs and geographical indications. Universal Law Publishing
6. Modern Control Systems Theory, M Gopal, New Age International, 1993, 2nd Edition
7. Introduction to linear Systems Theory, C. T. Chen, Holt, Rinehart and Winston, 1970

503105: ELECTIVE – I

CODE	TEACHING SCHEME	EXAMINATION SCHEME						CREDITS
		Paper						
503105	Lect/week	In semester Assessment	End Semester Assessment	TW	Oral / Presentation	Total		
	5	50	50	--	--	100		5

Code No.	Module I(Credit 4) (Select any one)	Code No.	Module II(Credit 1) (Select any one)
503105 M-I(i)	Automation and Robotics	503105 M-II(i)	Project Management
503105 M-I(ii)	Modeling of Dynamic System	503105 M-II(ii)	IPR and Patent Law
503105 M-I(iii)	Industrial Automation and Control	503105 M-II(iii)	Technical Communication
--	--	503105 M-II(iv)	Smart Grid Technologies
--	--	503105 M-II(v)	Signal Processing of Power Quality Disturbances

503105M-I (i): AUTOMATION AND ROBOTICS

Teaching Scheme:
Lectures: 4 Hrs./ Week
Credits: 4

Examination Scheme:
In-Semester Assessment: 25
End Semester Assessments: 50

Prerequisites: Mathematics, mechanics, control system-I and microcontroller and its programming.

Course Objectives: Course objectives are to

- ✓ Be familiar with the automation and brief history of robot and applications.
- ✓ Acquire the knowledge on advanced algebraic tools for the description of motion.
- ✓ Give the student familiarities with the kinematics of robots.
- ✓ Give knowledge about robot end effectors and their design.
- ✓ Give knowledge about various Sensors and their applications in robots
- ✓ Develop the ability to analyze and design the motion for articulated systems.

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

- ✓ Explain the basic principles of Robotic technology, configurations and control of Robots Vs automation.
- ✓ Explain the basic principles of programming and apply it for typical Pick & place, loading & unloading applications.
- ✓ Calculate the forward kinematics and inverse kinematics of serial and parallel robots.
- ✓ Design appropriate trajectory planning as well as path planning for a robotic system and its motion control.
- ✓ Design and implement robot which can meet dynamic constraints, latest algorithms & analytical approaches.
- ✓ Choose the appropriate Sensor and Machine vision system for a given application.

Unit 1: Automation

Basic concept of automation; types of automation: fixed, flexible and programmable and their comparative study; Modelling and simulation for plant automation; Introduction to NC and CNC machines; Arm and hand prostheses; exoskeletons; locomotive mechanism. [**06 Hrs]**

Unit II: Fundamentals of Robot Technology

Robotics: A brief history; definition; laws of Robotics; Concept of Work cell, Basic components of robot, Specifications of robot: degrees of freedom (DOF), accuracy, repeatability, spatial resolution, compliance, loads carrying capacity, speed of response, work volume, work envelope, reach etc.; links & Joints; end effectors; Robot classification. Factors related to use Robot Performance, Basic Robot Configurations and their Relative Merits and Demerits, the Wrist & Gripper Subassemblies. [**08 Hrs]**

Unit III: Kinematics of Robot Manipulator: Introduction, General Mathematical Preliminaries on Vectors & Matrices, Direct Kinematics problem, Geometry Based Direct kinematics problem, Co-ordinate and vector transformation using matrices, Rotation matrix, Inverse Transformations, Problems on composite Rotation matrix, Homogenous Transformations, Robotic Manipulator Joint Co-Ordinate System, Euler Angle & Euler Transformations, Roll Pitch-Yaw(RPY) Transformation, DH Representation & Displacement Matrices for Standard Configurations, Jacobian Transformation in Robotic Manipulation. [**10 Hrs]**

Unit IV: Trajectory Planning and Robot Control:
Introduction; Trajectory Interpolators; Basic Structure of Trajectory Interpolators; Cubic Joint Trajectories; General Design Consideration on Trajectories:4-3-4 & 3-5-3 Trajectories; Via point trajectories. Control of Robot manipulator: joint position controls (JPC), resolved motion position controls (RMPC) and resolved motion rate control (RMRC). [**08 Hrs]**

Unit V: Dynamics of Robotic Manipulators:
Introduction, Preliminary, Generalized Robotic Coordinates, Jacobian for a Two link Manipulator, Euler Equations, The Lagrangian Equations of motion; Application of Lagrange–Euler (LE); Dynamic Modelling of Robotic Manipulators; Velocity of Joints, Kinetic Energy T of Arm; Potential Energy V of Robotic Ar;, The Lagrange L; Two Link Robotic Dynamics with Distributed Mass. [**08 Hrs]**

Unit VI: Robot Sensing & Vision:
Various Sensors and their Classification; Use of Sensors and Sensor based System in Robotics; Machine Vision System, Description, Sensing, Digitizing, Image Processing and Analysis; Application of Machine Vision System; Robotic Assembly Sensors and Intelligent Sensors.
[**08 Hrs]**

Text Books:

1. Richard D. Klafter, Thomas A. Chemielewski, Michael Neign "Robotic Engineering – An Integral Approach", Prentice Hall of India Pvt. Ltd., 2002.

Reference Books:

1. Robert J. Schilling, "Fundamentals of Robotics: Analysis and Control", Prentice Hall of India, New Delhi.
2. John J. Craig, "Introduction to Robotics: Mechanics and Control", Pearson Education.
3. K. S. Fu., R. C. Gonzalez, C. S. G. Lee, "Robotics: Control Sensing, Vision and Intelligence", International Edition, McGraw Hill Book Co.
4. R. K. Mittal, I. J. Nagrath, "Robotics and Control", Tata McGraw Hill Publishing Company Ltd., New Delhi.

503105 M-I(ii):MODELING OF DYNAMIC SYSTEM

Teaching Scheme:
Lectures: 4 Hrs./ Week
Credits: 4

Examination Scheme:
In-Semester Assessment: 25
End Semester Assessments: 50

Prerequisites: Mathematics,Control systems, electrical network, signal processing, thermal and fluid systems

Course Objectives: Course objectives are to

- ✓ Learn the concept of dynamic systems
- ✓ Understand modeling of physical systems for control system studies.
- ✓ Develop model of mechanical, electrical, fluid systems
- ✓ Learn various methods of developing model of dynamic systems

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

- ✓ Explain meaning of dynamic systems and classify various dynamic systems
- ✓ Develop a mathematical model from electrical and mechanical systems
- ✓ Use thermal and fluid properties to develop mathematical model for control system analysis
- ✓ Use of frequency response techniques and simulation software to develop model of physical system.
- ✓ Employ statistical tools to obtain model from system input and output data.
- ✓ Use of distributed parameter model

Unit I

Dynamic systems, Examples of dynamic systems, Definitions related to dynamic systems, Classification of system inputs, classification of system models. System modeling and simulation. (8Hrs)

Unit II: Modeling of Mechanical and Electrical Systems:

Translational systems: Springs, Dampers, Mass, Rotational Systems;D'Alembert's Principle, Lagranges's Equation, Three dimensional motion, Electric Systems: Basic Elements, Passive Circuit Analysis, Active circuit analysis: The operational amplifier Mechanics. (8Hrs)

Unit III: Fluid Systems:

Properties of fluids, density, equation of state, liquids and gases, viscosity, propagation of speed, Thermal properties, Reynolds Number Effects. Derivation of passive components, resistance, inductance and capacitance. Thermal System: Basic Effects, conduction, convection and Radiation, Circuit analysis of static thermal system: Signal and Multiple lumped capacitance modeling. (8Hrs)

Unit IV: Transform Methods for Generalized Response:

Impulse response, Convolution integral: Response to arbitrary inputs when impulse response is known, Frequency response, Response to periodic Inputs, transient inputs and random signal.

Simulation Methods: Limitations of analytical methods, Analog Simulation. Digital Simulation: Specific Digital Simulation techniques. (8Hrs)

Unit V: Generalized Modeling Methods:

Frequency response methods, Pulse testing methods, Random signal testing methods, Parameter tracking methods, Multiple regression and least square methods, Subsystem Coupling Methods.

(8Hrs)

Unit VI: Applications of Distributed Parameter Models

Longitudinal vibrations of a rod, Lumped parameter approximations for rod vibration, Conduction, heat translation in an insulated bar, Lumped parameter approximations for heat transfer in insulated bar. Magnetic levitation system for an Experimental Rail vehicle.

(8Hrs)

Text Books:

1. System Modeling and Response: Theoretical and Experimental Approaches. Ernest O. Dobling, John Wiley and Sons, 1980
2. Modeling and Simulation of Dynamic Systems: Robert Woods, Kent L. Lawrence, Prentice Hall

Reference Books:

1. Simulation Modeling and Analysis: Averill M. Law, W. David Kelton. McGraw Hill
2. System Dynamics: Modeling Analysis, Simulation, Design: Ernest O. Dobling, Marcel Dekker Inc.
3. Modeling of Dynamical Systems Vol. I: H. Nicholson (Editor), Peter Peregrinus Ltd., on behalf of IEE (Useful for unit 6) 116842, 1980 Edition
4. Dynamic Modeling and Control of Engineering Systems: J. LowenSheaser, Bohan T. Kulawski Macmillan Publishing Company NY, 158275, 1990 Edition

503105 M-I (iii): INDUSTRIAL AUTOMATION AND CONTROL

Teaching Scheme:
Lectures: 4 Hrs./ Week
Credits: 4

Examination Scheme:
In-Semester Assessment: 25
End Semester Assessments: 50

Prerequisites: Mathematics, PLC, Measurement, PID controllers, electrical drives.

Course Objectives: Course objectives are to
- ✓ Understand the architecture of industrial automation system
- ✓ Know operation of sensors, automatic PID, PLC and industrial drives in the automation
- ✓ Get familiar with the best practices in the industrial automation.

Course Outcomes: After the successful completion of this course, the student will be able to:
- ✓ Classify various existing industrial automation systems
- ✓ List sensors used in automation industry to measure temperature, pressure, force etc.
- ✓ Design PID control for industrial processes
- ✓ Implement industrial process control logic using PLC
- ✓ Enumerate hydraulic, pneumatic actuators, valves used in the automation industry
- ✓ Select appropriate drive for the particular application

Unit I: Introduction
Architecture industrial automation system, development trends in industrial automation, classification of existing systems, and functionality of industrial automation system. Relay and contactor logic, AC and DC relays and their role for load control. Power and Auxiliary contactors and their usage for load control. [8Hrs]

Unit II: Industrial Measurement System Characteristics
Sensors and control logic, control using potential free output sensors Control using PO, PC, NO, NC type output sensor, 2W(2wire),3W(3 wire),4W(4wire) and 4WC sensors, Linear potentiometer Timer hardware architecture, Controlling industrial system using timers Controlling industrial system using counters .Temperature Measurement, Pressure, Force and Torque Sensors, Motion Sensing, Flow Measurement, Signal Conditioning, Data Acquisition Systems. [8Hrs]

Unit III: Automatic Control
Introduction, P-I-D Control, manual and auto PID Control Tuning, Feed forward Control Ratio Control, Time Delay Systems and Inverse Response Systems, Special Control Structures. Temperature controller hardware architecture. [8Hrs]

Unit IV: PLC

Introduction to Sequence Control, PLC, RLL(Relay Ladder Logic), Sequence Control. Scan Cycle, Simple RLL Programs, Sequence Control. More RLL Elements, RLL Syntax, A Structured Design Approach to Sequence, PLC Hardware Environment, Introduction To CNC Machines, Contour generation and Motion Control, Allen Bradley PLC and SIEMEN PLC.

[8Hrs]

Unit V: Industrial Control

Basics of hydraulics, Hydraulic components their functions and symbols Hydraulic actuators, Pumps and its operation, pump control, Hydraulic valves (Direction control, pressure and flow control), special valves, pressure gauges and switches, hydraulic logic circuits, Hydraulic Control System, Multiple pressure and speed operations, Industrial Hydraulic Circuit, Pneumatic systems and components Pneumatic Control Systems, compressor operation and control, air treatment.

[8Hrs]

Unit VI: Industrial Drives

AC Drive basics, Electrical specifications and hardware architecture .AC drive and AC motor specification matching.AC drive power wiring and Interfacing input and output signals. Operation and control of AC motor in scalar mode. Operation and control of AC drive in vector. control mode.Performance verifications of special features of AC drive.Requirement and specifications of input and output chokes,braking applications, methodology and specifications of braking resistors.Selection of power,motor and signal cables for AC drive application. Wiring and lay outing guidelines of AC drive .Energy Savings with Variable Speed Drives, DC Motor Drives, DC and BLDC Servo Drives. [8Hrs]

References:

1. Lingefeng Wang, Kay Chen Tan,"Modern Industrial Automation and Software Design" John Wiley & Sons Inc.
2. K. L.S. Sharma, “ Overview of Industrial Process Automation”, Elsevier
3. KokKiong “Drives and Control for Industrial Automation”, Springer

503105 M-II (i): PROJECT MANAGEMENT

Teaching Scheme:
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme:
In-Semester Examination: 25 Marks

Course Objectives: Course objectives are to

- ✓ Learn planning, management and execution of project in effective manner
- ✓ Understand the importance of quality control and risk management

Course Outcomes: Upon successful completion of this course, the student will be able to

- ✓ Prepare the project scheduling using different techniques and plan, manage and control the project quality.
- ✓ Measure, asses and manage the project risk with the help of different techniques.

Unit I:
Project Scheduling: Gantt chart and its application, AOA (Activity on Arrow diagram), AON(Activity on Node) Diagram, Precedence diagramming methods (PDM), Critical Path Method(CPM), Programme Evaluation and Review Technique (PERT), GERT (Graphical Evaluation and Review Technique), Resource allocation, Line of Balancing and crashing the network.
Project Quality Management: The processes of project quality management, Quality planning, assurance and control, Quality of procured items, Techniques of quality assurance and control, project execution and control, International Project Management. [9Hrs]

Unit II:
Project Risk Management: Introduction, Managing risks in projects, Measurement andassessment of risk, Sources of risks. Risk: - Adjusted discount rate method, certainly equivalentmethod, correlation coefficient, portfolio risks, diversible& non-diversible risks, CAPM (Capital Asset pricing model) case studies of project management, computer aided project management.
[5Hrs**]**

Text Books:
1. K. Nagarajan, “Project Management”, 5th Edition, New Age International Publishers, 2010.
2. Prasanna Chandra, “Projects: planning, analysis, selection, implementation and review”, 4th Edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 1995.
3. Rosy Burke, “Project Management: planning and control technique”, Wiley India, 2003
4. S. Chaudhary, “Project Management”, Tata McGraw Hill, 1988.

Reference Books:
1. J. R. Meredith, S. J. Mantel, “Project Management: A managerial approach”, Wiley India, 2010
2. John M. Nicholas, Herman Steyn, “Project Management”, 3rd Edition, Elsevier Inc., 2008
3. Samuel Mantel, Jr. J. R. Meredith, S. M. Scafer, M. M. Sutton, M. R. Copalan, “Project Management” 1st Edition, 2011

503105 M-II(ii): IPR AND PATENT LAW

Teaching Scheme:
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme:
In-Semester Examination: 25 Marks

Course Objectives: Course objectives are to
- ✓ Gain knowledge of IPR and patents while working on the project
- ✓ Understand various laws associated with IPR

Course Outcomes: Upon successful completion of this course, the student will be able to
- ✓ Define intellectual property and distinguish between different types of IPR with legal requirements.
- ✓ Describe laws of IPR in different countries and international.

Unit I
Intellectual property, History, Types(Seven types of Intellectual Property Rights) viz.
Patent, Industrial Designs, Trademark, Copyright, Geographical Indication, Integrated Circuit Layout, Trade Secrets.
Patents and standards: History of patent law, History of Indian Patent System, Utility model Procedures: Patent application, Patent infringement and enforcement, Patent licensing, Patent prosecution. Criteria of patentability, Rights granted for IP owners. Legal requirements: Patentable subject matter, Novelty, Utility (patent), Inventive step and nonobviousness, Industrial applicability, Person skilled in the art, Prior art, Inventor ship, Sufficiency of disclosure, Unity of invention, Intellectual property brokering, Intellectual property education, Intellectual property infringement,Intellectual property valuation. [7 Hrs]

Unit II
CEN and CENELEC Patent Policy, CEN-CENELEC Guidelines for Implementation of theCommon IPR Policy on Patents, Declaration of patents. Copyright: CEN-CENELEC copyright policy, piracy. Industrial design rights Trademarks: Geographical indication, Protected designation of origin, Trade dress. Other types: Database right, Fashion law, Indigenous intellectual property, Industrial design rights (or registered designs), Intellectual rights to magic methods, Internet domain name, Know how, Mask work (or Integrated circuit layout design protection), Open-source software, Orphan drug rights, Personality rights, Plant breeders' rights Patent law by region or country: Indian patent law, Australian patent law, Canadian patent law, Patent law of the People's Republic of China, European patent law, Japanese patent law, United States patent law.
[7 Hrs]

Text Books:
1) Intellectual Property Rights – Prabuddha Ganguli, Tata McGraw Hill publishing Company Ltd.
2) Satarkar S.V., Intellectual Property Rights and Copy Right. ESS Publications.

References:
www.cen.eu, www.cenelec.eu, www.cencenelec.eu, http://ipindia.nic.in/,
http://ipindia.nic.in/ipr/patent/patents.htm, http://www.ipaustralia.gov.au/ (Australian Intellectual property), http://guides.slv.vic.gov.au/, http://www.cipo.ic.gc.ca (Canadian patent office)
http://www.epo.org(Europian patent office),
http://www.academicleadership.org/emprical_research/The_State_of_Intellectual_Property_Education_Worldwide.shtml (Intellectual property education)

503105 M-II (iii): TECHNICAL COMMUNICATION

Teaching Scheme:
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme:
In-Semester Examination: 25 Marks

Course Objectives: Course objectives are to
- ✓ Learn effective communication strategies and use them
- ✓ Promote use of standard software to write technical documents for effective writing

Course Outcomes: Upon successful completion of this course, the student will be able to
- ✓ Design effective technical presentation and communicate it in verbal and written form.
- ✓ Write technical report and paper in typesetting software LATEX.

Unit I

Effective Presentation Strategies

Define the purpose of presentation, Analyzing audience and locale, organizing contents, Preparing an Outline, Visual Aids, Understanding the nuance of delivery, sample speech and practice the presentation. [3Hrs]

Listening techniques

Types of listening, listening with a purpose, barriers to listening, listening comprehension, effective listening strategies, listening in conversational interaction, team listening. [2Hrs]

Speech techniques

Conversation and oral skills, strategies for good conversation, techniques to develop effective word accent, word stress, primary and secondary stress, use of correct stress pattern, developing voice quality, developing correct tone. [2Hrs]

Unit II:

Writing technical reports, research papers, dissertation, thesis and research proposals. Important parts of reports like abstract, results, conclusion. Supplementary parts like list of symbols, list of tables, annexure, references etc. Making title page, writing mathematical equations, including graphics, making tables and writing references using LaTex/ MiKTeX.
Assignment for one technical proposal, one research paper and one technical report should be submitted using LaTex/MikTeX for in semester assessment. [7 Hrs]

Reference Books:

1) Technical Communication-Principals and Practice, Meenakshi Raman, Sangeeta Sharma, OXFORD university Press.
2) Effective Technical Communication, M Ashraf Rizvi, TATA McGRAW HILL
3) Leslie Lamport, ' Latex: A document preparation system' Addison Wesley, Reading, Massachusetts, second edition, 1994, ISBN 0-201-52983-1.

503105 M-II(iv): SMART GRID TECHNOLOGIES

Teaching Scheme:
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme:
In-Semester Examination: 25 Marks

Course Objectives: Course objectives are to

- ✓ Create awareness about the IEEE standards available for Smart Grid
- ✓ Gain knowledge of various aspects of smart grid technologies

Course Outcomes: Upon successful completion of this course, the student will be able to

- ✓ Draw and describe detail block diagram of phasor measurement unit and its applications
- ✓ Apply wide area measurement system with the help of different standard in power system.

Unit I

Need of Synchrophasor Measurements, Phasor Measurement Unit : Architecture, Functions, Optimal Placement of PMUs, phasor data concentrators and associated communication system. Visualization tools to enhance visibility and control within transmission system, PMUmeasurements and sampling rates State Estimation &observability by using PMU, phasor data usefor real time operation, frequency stability monitoring and trending, power oscillation, voltagemonitoring and trending. Alarming and setting system operating limits. Dynamic line rating andcongestion management, outage restoration. Application of PMU for wide area monitoring andcontrol. [9Hrs]

Unit II

WAMS (Wide Area Measurement system): Architecture, Components of WAMS, GUI (GraphicalUser Interface), Applications: Voltage Stability Assessment, Frequency stability Assessment,Power Oscillation Assessment, Communication needs of WAMS, WAMPAC (Wide AreaMonitoring Protection & Control), RAS (Remedial Action Scheme). Standards: IEEE 1344, IEEEC37.118 (2005), IEEE Standard C37.111-1999 (COMTRADE), IEC61850 GOOSE.
[5Hrs]

Text Books:

1. "Synchronized Phasor Measurements and Their Applications", Arun G. Phadke, J.S.Thorp, Springer Publication.
2. "Event detection and visualization based on phasor measurement units for improvedsituational awareness", Joseph Euzebe Tate, UMI Dissertation Publishing.
3. "Wide Area Monitoring, Protection and Control: The Gateway to Smart Grids", FahdHashiesh, M. M. Mansour ,Hossam E. Mostafa Fahd Hashiesh , M. M. Mansour ,
Hossam E. Mostafa.

Reference Books:

1. "Power System State Estimation", Mukhtar Ahmad
2. "Computer Relaying for Power Systems", Dr. Arun G. Phadke, Dr. James S. Thorp,
Wiley Publication, Second Edition.
3. "SMART GRID Infrastructure & Networking", KRZYSZTOF INIEWSKI, TATA McGRAW HILLEDITION.

503105 M-II(v): SIGNAL PROCESSING OF POWER QUALITY DISTURBANCES

Teaching Scheme:
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme:
In-Semester Examination: 25 Marks

Prerequisites: Power quality, signals and systems, Fourier transform

Course Objectives: Course objectives are to
- ✓ Use of signal processing techniques to detect power quality events
- ✓ Use of software tools to classification of power quality disturbances

Course Outcomes: Upon successful completion of this course, the student will be able to
- ✓ List power quality disturbances and their origin
- ✓ Understand use of signal processing tools for processing stationary and non-stationary signals for power quality analysis

Unit I: Introduction
Power Quality, Signal Processing and Power Quality, Electromagnetic Compatibility, Standards, Overview of Power Quality Standards, Compatibility between Equipment and Supply, Origin of events, Voltage Frequency Variations, Voltage Magnitude Variations, Voltage Unbalance, Voltage Fluctuations and Light Flicker, Waveform Distortion. [8 Hrs.]

Unit II: Processing of Signals
Processing of stationary signals: Over view of methods, Parameters that Characterize Variations, Power Quality Indices, Frequency-Domain Analysis and Signal Transformation, Estimation of Harmonics and Interharmonics, Estimation of Broadband Spectrum. Processing of non-stationary signals: Overview of Some Nonstationary Power Quality Data Analysis Methods, Discrete STFT for Analyzing Time-Evolving Signal Components, Discrete Wavelet Transforms for Time–Scale Analysis of Disturbances, Block-Based Modeling, Models Directly Applicable to Nonstationary Data, 4 [8 Hrs.]

References:

1. "Signal Processing of Power Quality Disturbances", Math H. Bollen, Irene Gu, July 2006, Wiley-IEEE Press
2. "Understanding Power Quality Problems: Voltage Sags and Interruptions", Math H. Bollen Wiley 2000
3. "Electric Power Quality", Surajit Chattopadhyay, Madhuchhanda Mitra, Samarjit Sengupta, Springer

503106: LAB PRACTICE – I

Teaching Scheme **Examination Scheme**
4Hrs / Week Term Work: 50 Marks
Credits:4 Oral: 50 Marks

A minimum of eight experiments should be performed under Lab Practice – I. Out of which minimum six experiments should be from the list below. Minimum six experiments should be based on compulsory subjects. A list of experiments that may be performed under various subjects of semester - I is given below as a guideline.

1. ***Optimization Techniques in Control Systems***

a) Give Algorithm and flow chart for steepest descent method/conjugate gradient method with suitable example.
b) State and explain standard LP Problems (or application of simplex method for LPP) with suitable example
c) State and explain any one of the method for unconstrained optimization (Dichotomous search, Fibonacci method and Golden section method)
d) Dynamic programming in continuous time/Discrete time system for optimal solution of control system

2. ***Automation in Manufacturing****:*

a) Motor control using dSPACE
b) Hardware realization of closed loop control of a lightly damped control system
c) Control of level/temperature/ph/flow-rate using industrial PID. Performance comparison with different parameters for PID
d) PLC Programming Experiments for any two systems. Water Level Control/Control of Batch Process Reactor/ Lift Control/ Speed Control of AC Servo Motor /Automatic Star Delta Starter of Three Phase Induction Motor

3. ***Nonlinear Control Systems:***

a) Simulate the various nonlinearities using Op. Amps.
b) Construct Phase Plane Trajectory by any method and compare it with MATLAB simulation for a nonlinear system.
c) Determination of stability of nonlinear systems using Lyapunov function.
d) Construct trajectories of Vander Pol’s equation.

Semester II

503107: MULTIVARIABLE AND OPTIMAL CONTROL SYSTEM

Teaching Scheme:
Theory: 4Hrs/Week
Credits: 4

Examination Scheme:
In-Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks

Prerequisites: Single input single output system, Nonlinear system, transfer function, state space analysis etc

Course Objectives: Course objectives are to

- ✓ Apply MIMO technique in control system
- ✓ Model various representation of MIMO system
- ✓ Test various properties of MIMO system
- ✓ Organizeand design various types of observers
- ✓ Examine various optimal methods
- ✓ Find optimal solution for control system

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

- ➢ Apply various MIMO techniques and representation in control system
- ➢ Classify and compare various properties of MIMO System
- ➢ Estimate and design various type of observers
- ➢ List and formulate different types of optimal control methods
- ➢ Design and optimize control system
- ➢ Give optimized solution for control system

Section I: Multivariable Control Systems

Unit I

A)Example of multivariable control systems, differential operator and transfer matrix, state-space models and system solution.

B)Controllability, observability, state estimation, pole allocation, stability and reproducibility,

(8 Hrs)

Unit II

Concept of state observer and disturbance observer, Evolution of state and disturbance observers a brief history, brief revision of Luenberger Observer, Limitations, Sliding Mode Observers: mathematical model of observer, robustness properties, procedure for gain selection, error analysis, stability, applications, advantages and limitations (8Hrs)

Unit III

Nonlinear Extended State Observer (Nonlinear ESO): mathematical model of observer, nonlinear gain selection, Linear ESO, error analysis, applications, stability, advantages and limitations. Comparison of Sliding mode observer and ESO observer. (8 Hrs)

Section II: Optimal Control System

Unit IV

Formulation of optimal control problem, Minimum time, energy, fuel problems, Calculus of variations, Minimization of functions, Control and state variable inequality constraints. Hamiltonian formulation of optimal control problem, Hamilton-Jacoby equation, Linear regulator problem.

(8 Hrs)

Unit V

Quadratic performance criterion, Time invariant state regulator, Numerical solution of Matrix Riccati Equation: Direct integration, a negative exponential method and iterative method, Pontryagin's minimum principle, application to optimal control of discrete and continuous systems.

(8 Hrs)

Unit VI

Suboptimal linear regulators: Continuous time and discrete time systems, Minimum time control, normality and existence uniqueness of control, Bang-Bang Control, singular solutions. (8 Hrs)

Text Books:

1. "Linear Multivariable Control System",Y. S. Apte, New Age International Publication 1996
2. "Multivariable Control System",W. M. Wonham,Springer-Verlag, 1985
3. "Optimal Control-An Introduction": O. Kirk, Prentice Hall
4. "Optimum Systems Control",A. P. Sage, II Edition
5. ."Sliding Mode Control: Theory and Applications", C. Edwards, S. Spurgeon, CRC Press
6. "Disturbance Observer-Based Control: Methods and Applications",Shihua Li, Jun Yang, Wen-Hua Chen, Xisong Chen, CRC Press.

Reference Books:

1. "Linear System Theory and Design",C. T. Chen, 3rd Edition, Oxford 1999
2. "Multivariable Control", N. K. Sinha, Marcel Dekker Inc., New York
3. "Control System Design",Goodwin, Graebe, Salgado
4. "Optimization Theory and Applications",S. Rao, Wiley Eastern
5. "Sliding Mode Control and Observation", Yuri Shtessel, Christopher Edwards, Leonid Fridman, Arie Levant, Birkhäuser Publication
6. Wang, W. and Gao, Z., 2003, June. A comparison study of advanced state observer design techniques. In *American Control Conference, 2003. Proceedings of the 2003* (Vol. 6, pp. 4754-4759). IEEE.

503108:CONTROL OF POWER ELECTRONIC CIRCUITS

Teaching Scheme:
Theory: 4Hrs/Week
Credits: 4

Examination Scheme:
In-Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks

Prerequisites: Power Electronics, Control systems, Linear Systems, Electrical Network, Analog and Digital Electronics

Course Objectives: Course objectives are to

- ✓ Introduce various types models used for control design in power electronics
- ✓ Design controller for the power electronic converter using modern control theory
- ✓ Introduce sliding mode control and embedded control as a tool for controller design

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

- ✓ Choose suitable power electronics model for the controller design
- ✓ Acquire knowledge about control principle, goal and issues in the Power electronic converters.
- ✓ Develop model of DC-Dc converter for control design purpose.
- ✓ Design controller for DC-DC converter based on modern control techniques
- ✓ Devise sliding mode controller for the power electronic circuit.
- ✓ Understand implementation of power electronic control circuit using embedded systems.

Unit I: Introduction

Introduction: Role and Objectives of Power Electronic Converters, Requirements of Modelling, Simulation and Control of Power Electronic Converters, Models, Model Types: Switched Models, sampled-Data Models, Averaged Models, Large-Signal and Small-Signal Models, Behavioural Models, Relations Between Various Types of Models, Relations Between Modelling and Control [8Hrs]

Unit II:

General Control Principles of Power Electronic Converters, Control Goals in Power Electronic Converter Operation, Specific Control Issues Related to Power Electronic, Different Control Families [8 Hrs]

Unit III: Modelling of DC-to-DC Power Converters

Introduction, the Buck, Boost, Buck-Boost Converter, Model of the Converter Normalization, Equilibrium Point and Static Transfer Function, Prototype. [8Hrs]

Unit IV:

Linear Feedback Control for buck, book and buck-boost converter, Pole Placement by Full State Feedback, Pole Placement Based on Observer Design, Reduced Order Observers, Flatness, Generalized Proportional Integral Controllers, Passivity Based Control, A Hamiltonian Systems Viewpoint. [8 Hrs]

Unit V: Linear Control Approaches for DC-AC and AC-DC Power Converters

Introductory Issues, Control in Rotating dq Frame Resonant Controllers, Necessity of Resonant Control, Basics of Proportional-Resonant Control, Design Methods, Implementation Aspects Control of Full-Wave Converters [8Hrs]

Unit VI: Variable-Structure Control of Power Electronic Converters

Introduction, Sliding Surface, General Theoretical Results, Reachability of the Sliding Surface: Transversality Condition, Equivalent Control, Dynamics on the Sliding Surface, Variable-Structure Control Design, General Algorithm, Application Example [8Hrs]

Unit V: Design of Embedded Control

Introduction, Analog and Digital Control, Developing an Embedded Controller, A BriefIntroduction to Model-Based Design, Case Study of an Embedded Control System Design

[8 Hrs]

References:

1. Power Electronic Converters Modelling and Control with Case Studies, Seddik Bacha Iulian Munteanu Antoneta Iuliana Bratcu, Springer
2. Control Design Techniques in Power Electronics Devices, Hebertt Sira-Ramírez and Ramón Silva-Ortigoza, Springer
3. Control Systems for Power Electronics A Practical Guide, Mahesh Patil PankajRodey, Springer
4. Ned Mohan et.al “Power electronics: converters, applications, and design” John Wiley and Sons, 2006
5. Rashid “Power Electronics” Prentice Hall India 2007.
6. G.K.Dubey et.al “Thyristorised Power Controllers” Wiley Eastern Ltd., 2005, 06.

503109: DIGITAL SIGNAL PROCESSING AND ITS APPLICATIONS

Teaching Scheme	**Examination Scheme**
Lectures: 4 Hrs./Week	In-Semester Examination : 50 Marks
Credits: 4	End Semester Examination: 50 Marks

Prerequisite: Fourier series, Fourier transform Z transform

Course Outcome: After the successful completion of this course, the student will be able to

- ✓ Classify discrete time signal and system and determine Z and inverse Z-transform of DTS.
- ✓ Determine frequency response of first and second order LTI system with phase and group delay.
- ✓ Derive frequency response of DTS using DTFT and DFT.
- ✓ Design and realize IIR filter using different techniques.
- ✓ Design and realize IIR filter using different window techniques.
- ✓ Apply basics of DSP in different applications of electrical engineering.

Unit I:

A) Discrete Signals and systems: Sampling of continuous time signals, quantization, aliasing, Sampling Theorem**,** Elementary discrete-time signals, classification, sequence operations, Discrete-time systems and classification, impulse response, linear convolution and its properties, Discrete-time systems described by difference equations. [4Hrs]

B) Z transform: Definition, basics, properties, inverse Z-transform using power series and partial fraction Solution of difference equation, Analysis of LTI system. [4Hrs]

Unit II: Frequency analysis of discrete time signals:

A) Discrete Time Fourier Transform: Frequency response of DTS, Discrete frequency spectrum and range, DTFT Definition and its properties. Numerical. [3 Hrs]

B) Discrete Fourier Transform: Definition and Properties of DFT, Circular convolution, Linear convolution using circular convolution, Fast Fourier Transform: Radix 2 DIT and DIF algorithms [5 Hrs]

Unit III: Time and Frequency response of discrete time systems:

A) Time Response: Natural response, forced response and total response, impulse response and step response [3Hrs]

B)Frequency response: frequency response of first order and second order systems, transfer function, steady state and transient response, phase and group delays, ideal filters and their pole zero locations, zero phase and linear phase transfer functions [5 Hrs]

Unit IV: IIR filters

Advantages and disadvantages of digital filter over analog filters, classification of digital filters: FIR and IIR, design of analog low pass Butterworth filter, Chebyshev filter, design of IIR filters from analog filters using bilinear transformation, impulse invariance. Realization of IIR filters: direct form I, direct form II, cascade and parallel. [8 Hrs]

Unit V: FIR filters

Comparison between FIR and IIR filters, symmetric and antisymmetric FIR filters, design of linear phase FIR filters using windows method (rectangular, Hanning and Kaiser), Realization of FIR filters by direct form, cascade form and parallel form. [8 Hrs]

Unit VI: Applications of DSP

1) Measurement of power
2) Measurement of frequency
3) PWM generation
4) Condition monitoring and speed control of Electrical Machines
5) Design of Discrete PID controller. [8 Hrs]

Text Books:

1. Mitra S., “Digital Signal Processing: A Computer Based Approach”, Tata McGraw-Hill, 1998, ISBN 0-07-044705-5
2. Proakis J., Manolakis D., “Digital signal processing”, 3rd Edition, Prentice Hall, ISBN 81-203-0720-8
3. P.RameshBabu “Digital Signal Processing” 4th Edition, Scitech Publication, Chennai

Reference Books:

1. Oppenheim A., Schafer R., Buck J., “Discrete time signal processing”, 2nd Edition, Prentice Hall, 2003, ISBN-81-7808-244-6
2. Rebizant, Waldemar, Szafran, Janusz, Wiszniewski, Andrzej, “Digital Signal Processing in Power System Protection and Control”, 1st Edition. Springer, 2011, ISBN 0857298011, 9780857298010

503110: (ELECTIVE- II)

<table>
<tr><th rowspan="2">CODE</th><th>TEACHING SCHEME</th><th colspan="5">EXAMINATION SCHEME</th><th rowspan="4">CREDITS</th></tr>
<tr><th rowspan="3">Lect/week</th><th colspan="2">Paper</th><th rowspan="3">TW</th><th rowspan="3">Oral / Presentation</th><th rowspan="3">Total</th></tr>
<tr><th rowspan="3">503110</th><th rowspan="2">In semester Assessment</th><th rowspan="2">End Semester Assessment</th></tr>
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<tr><td>5</td><td>50</td><td>50</td><td>-</td><td>-</td><td>100</td><td>5</td></tr>
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Code No.	Module I(Credit 4) (Select any one)	Code No.	Module II(Credit 1) (Select any one)
503110 M-I (i)	Robust Control Systems	503110 M-II (i)	Electric Vehicles
503110 M-I (ii)	Large Scale Systems	503110 M-II (ii)	Fundamentals of Cyber Security
503110 M-I (iii)	Advanced Digital Control Techniques	503110 M-II (iii)	Disaster Management
--	--	503110 M-II (iv)	Communication protocols in SCADA System
--	--	503110 M-II (v)	Mechatronics

503110 M-I (i): ROBUST CONTROL SYSTEMS

Teaching Scheme:
Lectures: 4 Hrs./ Week
Credits: 4

Examination Scheme:
In-Semester Assessment: 25
End Semester Assessments: 50

Prerequisites: Matrices, Linear Algebra, Control Systems, Optimal Control, optimization techniques

Course Objectives: Course objectives are to

- ✓ Introduce some common robust problems
- ✓ Understand H infinity controller for continuous and discrete systems
- ✓ Introduce robust and perfect tracking of continuous time and discrete time systems

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

- ✓ Identify common robust problems
- ✓ Understand mapping of continuous time to discrete time and vice-a-versa
- ✓ Get the solution of discrete time Riccati equations
- ✓ Appreciate H infinity optimization in continuous and discrete time system

Unit I: Introduction

Some common robust control problems. Linear system tools: Jordan and Real Jordan canonical forms, structural decomposition. (8Hrs)

Unit II: Structural mapping of Bilinear Transformations:

Mapping of continuous time to discrete time and vice a versa, existence condition of H∞ sub optimal controllers, continuous time system and discrete time system.
(8Hrs)

Unit III: Solution to Discrete time Riccati Equations:

Solutions to general DARE and H∞ -DARE. (8Hrs)

Unit IV: Information in continuous time and discrete time H ∞ optimization:

Full information feedback, output feedback, plants with imaginary axis zeros/unit circle zeros. (8Hrs)

Unit V: Solutions to continuous time and discrete time H ∞ problems:

Full state feedback, full order output feedback, reduced order output feedback. (8Hrs)

Unit VI

Robust and perfect tracking of continuous time and discrete time systems, solvability conditions and solutions; solutions to measurement feedback. (8Hrs)

Text Books:

1. Robust and H ∞ Control: Ben M. Chen, Springer Verlag, London, 2000
2. Essentials of Robust Control: K. Zhon, John C. Doyle, Prentice Hall Int. 1998

Reference Books:

1. Robust Control - The Parametric Approach: S. P. Bhattacharya, H. Chapellat, Prentice Hall Int. 1995
2. Robust Adaptive Control: Petros A. Ioannou, Jing Sun, Prentice Hall Int. Upper Saddle River, NJ07458
3. Robust Process Control: M. Morari and E. Zafiriou, Prentice Hall 1989
4. Feedback Control Theory: J. C. Doyle, B. A. Francis and A. R. Tannenbaum, Macmillan 1992.
5. A Course in H ∞ Control Theory: Francis
6. Optimal Controller, A General Robust Control in Control System Toolbox:- Robust Analysis, Robust Model Reduction:- MATLAB, Mathwork Inc. 1992.

503110 M-I (ii): LARGE SCALE SYSTEMS

Teaching Scheme:
Lectures: 4 Hrs./ Week
Credits: 4

Examination Scheme:
In-Semester Assessment: 25
End Semester Assessments: 50

Prerequisites: Formulation and solution of mathematical models in engineering and science applications in which one seeks to reduce the order of system, Knowledge of matrices

Course Objectives: Course objectives are to

- ✓ Study of interconnected feedback systems with a detailed engineering interpretation of the relevant methods and results.
- ✓ Study different approaches, which have led to the large number of available analytical and design methods and many recent results,
- ✓ Study of interrelationships of methods, advantages and drawbacks

Course Outcomes: Upon successful completion of this course, the student will be able to

- ✓ Understand large scale system
- ✓ Study methods to reduce order of system,
- ✓ Learn different aggregation methods,
- ✓ Understand frequency based system for model order reduction

Unit I: Modeling and parameter estimation

Introduction to probability theory, elements of estimation theory, application to parameter estimation for a dynamical model, some methods for the determination of transfer functions.
(8Hrs)

Unit II: Parameter estimation for large scale systems

Hierarchical parameter estimation, the multiple projection approach, recursive algorithm for the minimum variance estimator, simulation results. (8 Hrs)

Unit III: Aggregation

Aggregation of control systems, problem statement, properties of the aggregated system matrix, determination of the Aggregation matrix; Generation of feedback controls: linear dynamic optimization, bounds on sub optimality, eigenvalue assignment. (8 Hrs)

Unit IV: Model reduction techniques

Model analysis approach, mathematical development, three basic methods, and a general approach. Subspace projection methods, projection error minimization, and derivation of reduced model. Optimal order reduction, problem formulation, conditions of optimality, numerical algorithm, polynomial input functions. A comparative study. Extension to discrete systems, preliminary analysis, two model reduction techniques, output error minimization. Examples.
(8Hrs)

Unit V:

Model simplification using frequency domain techniques. Simplification by continued function expansions: three Cauer forms, a generalized Routh algorithm, simplified models, relationship to aggregation, and extension to discrete models;

Approximation methods for simplification: time moment matching, Padetype approximations, Routh-Hurwitz method. Minimal realization algorithms: conditions of reliability, Pade - type realizable models, aggregated model of Routh approximants. (8Hrs)

Unit VI: Time scale analysis

Block-diagonalization of continuous systems: problem statement, numerical algorithms, basic properties, relation to model aggregation. Feedback control design: two stage eigenvalue placement. Decoupling of discrete systems:, state feedback design. (8Hrs)

Text Books:

1. Magdi S. Mahmoud and Madan G. Singh – "Large scale systems modeling", Pergamon press, Oxford.
2. LanLunze – "Feedback control of Large scale system s", Prentice Hall International, New York.
3. Prof. B. Bandopadhyay – "Large scale systems"

Reference Books:

1. Magdi S. Mahmoud, Mohamed F. Hassan, Mohamed G. Darwish- "Large scale control systems - Theories and Techniques", Marcel Dekkar, Inc, New Y ork and Basel.
2. Yacov Y. Haimes – "Large scale systems", Publisher: North Holland publishing Co. Amsterdam.
3. Dragoslav D. Siljak – "Large scale dynamic systems: stability and structure", Norht Holland, New York.
4. International federation of automatic control (IFAC) symposia series, 1990, No. 9, "Large scale systems: theory and applications 1989.

503110 M-I (iii): ADVANCED DIGITAL CONTROL TECHNIQUES

Teaching Scheme:
Lectures: 4 Hrs./ Week
Credits: 4

Examination Scheme:
In-Semester Assessment: 25
End Semester Assessments: 50

Prerequisites: Basics of digital control systems, MATLAB Programming, Observability and Controllability, signal processing.

Course Objectives: Course objectives are to
- ✓ Introduce application of DSP processors in control design implantation
- ✓ Understand implantation of digital P, PI and PID controllers
- ✓ Realize digital control methods in modern control systems

Course Outcomes: Upon successful completion of this course, the student will be able to
- ✓ Learn digital modeling with sample and hold devices
- ✓ Analyze significance of P, PI PID controllers as well as lag, Lead Compensators.
- ✓ Design full order observer by separation principle.
- ✓ Explain design of FIR and IIR Filters with their applications.
- ✓ Classify TMS 320C5X And TMS320C54X.DSP Processors.
- ✓ LearnDSP applications such as detection of fetal heartbeats, human EEGs

Unit I: Digital Redesign
Introduction, Digital modeling with sample and hold devices, State variable formulation, Numerical integration, Frequency domain characteristics, Warping and Prewarping, Digital Redesiging, Closed form solution for Digital System, Partial matching of states. (8 Hrs)

Unit II: Design of Discrete Data control Systems
Design in the Z plane using root locus diagram, Digital P, PI, PID controller, Design of Discrete Data System using Z-Transform method, Simple lag, lead and lag-lead compensators. Pole zero cancellation. (8Hrs)

Unit III: Pole Placement Design and State Observer
State regulator design, Design of full State Observers, Design by separation principle. State feedback with integral control, digital control system with state feedback, deadbeat observer, Concept of Adaptive Control. (8 Hrs)

Unit IV:
Multirate DSP, Decimation, Interpolation, Design of Practical Sampling, Rate Conversion, Design

of FIR and IIR Filters, Finite word length effect in digital filters, discrete wavelet transform, adaptive filter components, algorithms. (8 Hrs)

Unit V:

Digital Signal Processors - Features, Fixed and Floating point DSP, Selection of DSP. Architecture and Instruction set of TMS 320C5X, instruction pipelining, Application Programs.

Architecture and Instruction set of TMS 320C54X DSP Processor, instruction pipelining, Application Programs. (8Hrs)

Unit VI: Applications and design studies

DSP applications, detection of fetal heartbeats during labour, Adaptive removal of ocular artefacts from human EEGs, Equalization of digital audio signals. Design studies. (8Hrs)

Text Books:

1. Discrete Time Control Systems, Pearson Education Asia, Katsuhiko Ogata .
2. Digital Control and State Variable Methods (conventional and Neuro Fuzzy Control), Tata McGraw Hill, M. Gopal
3. Digital Signal Processing Implementation using DSP Microprocessors with Examples from TMS 320C54XX, Thomas Publication, Avatar Singh, S. Srinivasan
4. Digital Signal Processor, B. Venkatramani, M. Bhaskar, Tata McGraw Hill

Reference Books:

1. Digital Control Systems, Oxford Press, Koop
2. Digital Signal Processing, Principles, Algorithms and Applications, Pearson Education, John G Proakis
3. Digital Signal Processing, Pearson Education, Ifeachar Jervis

503110 M-II (i): ELECTRIC VEHICLES

Teaching Scheme:
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme:
In-Semester Examination: 25 Marks

Course Objectives: Course objectives are to
- ✓ Know basics of electric vehicle technology
- ✓ Recognize the energy storage system in the electric vehicle

Course Outcomes: Upon successful completion of this course, the student will be able to
- ✓ Distinguish between different configurations of electric vehicles with merits and demerits.
- ✓ Recommend a drive for EV applications with suitable energy storage technology.

Unit I:
History and development of on-road Electric Vehicles (EV). Different configurations of hybrid EVswith block diagram representation, merits & demerits of different configurations in view of vehicleefficiency and energy storage system. [7 Hrs]

Unit II:
Energy storage systems – Basics of EV batteries, specifications, power density, Energy density, Charging &Discharging cycle and recommended methodologies for charging. Recommendeddrives for EV and converter topology used in EVs. [7 Hrs]

Reference books :

1. Ron Hodkinson& John Fenton, Light Weight Electric/ Hybrid Vehicle design, Butterworth Publications, Heinemann
2. H. A. Kiehne, Battery Technology Handbook, MARCEDLE KKEIRN,C
3. Sandeep Dhameja, Electric vehicle battery systems, Butterworth–Heinemann

503110 M-II (ii): FUNDAMENTALS OF CYBER SECURITY

Teaching Scheme:
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme:
In-Semester Examination: 25 Marks

Course Objectives: Course objectives are to

- ✓ Introduce concepts of cyber security
- ✓ Explore security models and cryptography

Course Outcomes: Upon successful completion of this course, the student will be able to

- ✓ Be familiar with information security awareness, a clear understanding of its importance, network security threats and countermeasures
- ✓ Master fundamentals of secret and public cryptography using different security models.

Unit I:
Introduction cyber security
Ethics and Law, What is a Cyber Crime / Social Theories, Computer Security: Then and Now, Computer System Security / Access Controls, Intrusion Detection: An Overview, Malicious Software Use and Detection [4 Hrs]
Security principles, threats and attack techniques: Introduction to security, Information security,Security triad: Confidential, Integrity, Availability, Focus of control, Security threats and attacks,Security management **[**2 Hrs**]**
Authentication and access control: Identification, Authentication, Authentication by passwords,Protecting passwords, Access control structures, Types of access control **[**2 Hrs**]**

Unit II:
Lattice and reference monitors: Security levels and categories, Lattice diagram, Reference monitors, Security kernel, Hardware security features, protecting memory **[**2 Hrs**]**
Security models: Bell-LaPadula, Biba, Non-deducibility, Non-interference, Other models **[**2 Hrs**]**
Cryptography: Cryptographic mechanisms, Digital signatures, Encryption, Certificates **[**2 Hrs**]**

Reference Books:
1. Dieter Gollmann, “Computer Security”, 2nd ed., John Wiley & Sons, 2006 ISBN: 0-470-86293-9
2. Rick Lehtinen and G.T. Gangemi, “Computer Security Basics”, O'Reilly Media, Inc., 2nd 2006 ISBN: 10: 0596006691

WEBSITES:
1) www.cert.org
2) www.microsoft.com/security/
3) www.sans.org
4) www.us.cert.gov

503110 M-II (iii): DISASTER MANAGEMENT

Teaching Scheme:
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme:
In-Semester Examination: 25 Marks

Course Objectives: Course objectives are to

- ✓ Establish basic background for the disaster management
- ✓ Investigate disaster management mechanism and planning

Course Outcomes: Upon successful completion of this course, the student will be able to

- ✓ Get knowledge about various disasters
- ✓ Make plan for relief and strategies of disaster management

Unit I: Disaster, Hazards and Vulnerability

Concept of disaster, different approaches, concept of risk, levels of disasters Disaster phenomena and events, Natural and man-made hazards; response time, frequency and forewarning levels of different hazards, Characteristics and damage potential of natural hazards; hazard assessment,dimensions of vulnerability factors; vulnerability assessment, Vulnerability and disaster risk,Vulnerabilities to flood and earthquake hazards. [7 Hrs]

Unit II:Disaster management mechanism and Planning

Concepts of risk management and crisis management, Disaster management cycle Response and Recovery, Development, Prevention, Mitigation and Preparedness Planning for relief, Strategies for disaster management planning , Steps for formulating a disaster risk reduction plan, Disaster management Act and Policy in India, Organizational structure for disaster management in India, Preparation of state and district disaster management plans. [7Hrs]

Students shall submit a detailed case study report on any disaster, prevention and preparedness.

Text books:

1. Alexander, D. Natural Disasters, ULC press Ltd, London, 1993.
2. Carter. W. N., Disaster Management: A Disaster Management Handbook, Asian Development Bank, Bangkok, 1991.
3. Chakrabarty U. K., Industrial Disaster Management and Emergency Response, Asian Books Pvt. Ltd., New Delhi 2007.
4. Disaster Management, Lotus Publications Pvt. Ltd.

Reference Books:

1. Manual on Natural Disaster Management in India, NCDM, New Delhi, 2001.
2. Disaster Management in India, Ministry of Home Affairs, Government of India, New Delhi, 2011.
3. National Policy on Disaster Management, NDMA, New Delhi, 2009.
4. Disaster Management Act. (2005), Ministry of Home Affairs, Government of India, New Delhi, 2005.
5. http://nidm.gov.in/ - National Institute of Disaster Management (NIDM) (Ministry of Home Affairs, Govt. of India) website

503110 M-II(iv): COMMUNICATION PROTOCOLS IN SCADA SYSTEM

Teaching Scheme:
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme:
In-Semester Examination: 25 Marks

Course Objectives: Course objectives are to
- ✓ Introduce SCADA systems and associated components
- ✓ Establish link between SCADA and communication system and create awareness of various protocols.

Course Outcomes: Upon successful completion of this course, the student will be able to
- ✓ Portray basic structure of SCADA system architecture.
- ✓ Describe communication and protocols in SCADA system.

Unit I:
SCADA Systems: Introduction and definitions of SCADA, **Basic SCADA system Architecture:** Human Machine Interface, Master Terminal Unit, RemoteTerminal Unit Communications for SCADA systems, Configuration of SCADA systems, SCADAsystem applications, SCADA systems in operation and control of interconnected power systems,Functions of SCADA systems, Common features of SCADA systems Automatic substation control,SCADA configuration, Energy management system, system operating states, system security, Stateestimation.

[7 Hrs]

Unit II:
Communication in power systems: Inductive coordination, Voice communication, carriersystems, Power line carrier systems, Microwave systems, co axial cable and optical fiber system,
two way mobile radio systems.**The Evolution of SCADA Protocols:** Overview of Open systems interconnection (OSI) Model,Functions of OSI Model Layers, OSI Protocols, Functions of Transmission control protocol /Internet protocol (TCP/IP) Layers, TCP/IP protocol, MODBUS model, DNP3 protocol, IEC61850layered architecture, Control area network, Control and Information Protocol (CIP), DeviceNet,Control Net, EtherNet/IP, Flexible Function Block process (FFB), Process Field bus (Profibus), TheSecurity Implications of the SCADA protocols.

[7 Hrs]

Text Books:
1. Ronald L. Krutz, “Securing SCADA System”, Wiley Publication.
2. Sunil S. Rao, “Switchgear and Protections”, Khanna Publication.
3. Robert Miller, James Malinowski “Power System Operation”, McGraw-Hill, Inc.

Reference Books:
1. Gordan Clark, Deem Reynders, “Practical Modem SCADA Protocols”
2. Stuart A Boyer, “SCADA supervisory control and data acquisition” International Society of Automation, North Carolina, 4th Edition.

503110 M-II (v): MECHATRONICS

Teaching Scheme
Lectures: 1Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination: 25 Marks

Course Objectives: Course objectives are to
- ✓ Provide knowledge of creating mathematical models of physical systems
- ✓ Give understanding of designing circuit for sensor interfacing

Course Outcomes: Upon successful completion of this course, the student will be able to
- ✓ Model electrical, mechanical, rotational, fluid and pneumatic systems.
- ✓ Design sensor interfacing circuit for physical system

Unit I: Introduction
Electrical Systems: Mathematical modeling of electro mechanical systems, RLC circuits, active and passive electrical circuits, PMDC motor, servo motor.
Mechanical Systems: Introduction to various systems of units, mathematical modeling of mechanical systems, Newton's laws, moment of inertia, forced response and natural response, rotational systems, spring mass system, free vibration, spring mass damper system, mechanical systems with dry friction, work energy and power.
Fluid and Thermal Systems: mathematical modeling of liquid level system, resistance and capacitance of liquid level systems with interaction.
Pneumatic Systems: mathematical modeling, resistance and capacitance of pneumatic systems, linearization of non-linear systems. [7 Hrs]

Unit II: Design and Sensor Interfacing
A) Design of mechanical elements: design considerations, codes and standards, optimum design process, design variables, cost functions, design constraints, optimum design. Design of hydraulic system: hydraulic circuit design, actuator design, selection of pumps, selection of valves, design of control circuits.
b) Sensor Interfacing: analog and digital sensors, sensors for motion measurement, digital transducers, human–machine and machine-machine interfacing devices and strategy.
[7 Hrs]

Reference Books:

1. C. W. Desiha, “Common Sensors and Actuators”, Prentice Hall.
2. Michel B. Histand and David G. Alciatore, “Introduction to Mechatronics and Measurement Systems”, Tata McGraw Hill.
3. Devadas Shetty, Richard A. Kolkm, “Mechatronics system design, PWS publishing company, 1997.

503111: LAB PRACTICE – II

Teaching Scheme	**Examination Scheme**
4 Hrs/Week	Term Work: 50 Marks
Credits: 4	Oral: 50 Marks

A minimum ofeight experiments should be performed under Lab Practice – II. Out of which minimum six experiments should be from the list below. Minimum six experiments should be based on compulsory subjects. A list of experiments that may be performed under various subjects of semester -II is given below as a guideline:

1. ***Multivariable and Optimal Control Systems***

   a) Representation of multivariable control system in S.S, D.O and T. M. form.
   b) Pole placement using linear state variable form
   c) Numerical solution of matrix Riccati equation.
   d) Full order observer design/minimum time (Bang-Bang) control.

2. ***Control of Power Electronic Circuits***

   a) To design of sliding mode control for any power electronic converter using MATLAB/LabView
   b) To design of controller using pole placement/observer for DC-DC converter using MATLAB
   c) To understand effect of unbalanced voltage on power electronic converter using power analyzer

3. Digital Signal Processing and its Applications

   a) Verification of linear and circular convolution in MATLAB
   b) To find the DFT and IDFT of a sequence in MATLAB.
   c) To design a filter for a signal mixed with noise.
   d) To generate a PWM signal using any digital signal processor.
   e) To design a discrete PID controller for an application

503112:SEMINAR – I

Teaching Scheme	**Examination Scheme**
4 Hrs/Week	Term Work: 50 Marks
Credits: 4	Oral/Presentation : 50Marks

Seminar I **s**hall be on the state of the art topic of student’s own choice based on relevant specialization approved by an authority. Topic should cover the advancement on the technology under specialization. The content of seminar report may include basic theory, concept, schematics, models, methods, economics, merits, demerits etc. relevant to the selected topic of seminar. A student should study sufficient number of papers from referred journals related to the topic in consultation with the guide. A guide should maintain weekly record of discussion related to the topic. The student shall submit the seminar report in standard format, duly certified by the concerned Guide and Head of the department/institute for satisfactory completion of the work.

Semester III

603101: ADVANCED DRIVES AND CONTROL

Teaching Scheme:
Theory: 4Hrs/Week
Credits: 4

Examination Scheme:
In-Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks

Prerequisites: Construction, working and characteristic of different electrical motors, Power Electronic Applications such as converter, inverter, chopper etc., Basic concept of control system

Course Objectives: Course objectives are to
- ✓ Study dynamics of electrical drives
- ✓ Study converter and chopper fed DC drives and its modeling
- ✓ Study effect of harmonics and voltage variation on inverter fed Induction motors
- ✓ Study vector control of Induction motor and its modeling
- ✓ Study power converter fed permanent magnet synchronous motor and its modeling
- ✓ Study modern control techniques in closed loop control of electrical drives

Course Outcomes: After completion of this course, student will be able to
- ✓ Match between motor and power converter.
- ✓ Analyze the operation of converter and chopper fed DC drives
- ✓ Analyze the operation of Inverter fed Induction Motors
- ✓ Analyze the operation of Vector control of Induction motor.
- ✓ Analyze the operation of Power converter fed synchronous motor.
- ✓ Understand modern control techniques used for closed loop control of electrical drives.

Unit I: Introduction to motor drives:
Classification, comparison of AC and DC drives, Basic elements, torque equations, component of load torque, multi-quadrant operation, equivalent drive parameters, components of power electronic drives, criteria for selection of drive components match between the motor and the load, calculation of time and energy in transient conditions, characteristics of mechanical systems, stability consideration, thermal consideration, thermal model of motor for heating and cooling, match between the motor and power electronics converter, closed loop control of drives.

(8 Hrs)

Unit II: DC drives
System model, motor rating, motor mechanism dynamics, drive transfer function, effect of armature current waveform, torque pulsations, adjustable speed drives, chopper fed and 1 phase converter fed drives, effect of field weakening. (8Hrs)

Unit III: A.C. Drives
Basic Principle of operation of 3 Phase motor, equivalent circuit, MMF space harmonics due to fundamental current, fundamental spatial MMF distributions due to time harmonics simulation,

effect of time and space harmonics, speed control by varying stator frequency and voltage, impact of nonsinusoidal excitation on induction motors, variable square wave VSI drives, variable frequency CSI drives, line frequency variable voltage drives. (8Hrs)

Unit IV: Induction Motor drives:

Review of induction motor equivalent circuit, effect of voltage, frequency and stator current on performance of the m/c, effect of harmonics, slip power recovery schemes-static Kramer drive and dynamic d.q. model, small signal model, voltage and current fed scalar control, direct and indirect vector control, sensor less vector control, direct torque and flux control.

(8Hrs)

Unit V: Synchronous motor drives:

Review of synchronous motor fundamental, equivalent circuit, dynamic d-q model, synchronous reluctance, sinusoidal and trapezoidal back emf permanent magnet motors, sinusoidal SPM machine drives, trapezoidal SPM machines drives, wound field machine drives, switched reluctance motor drives. (8Hrs)

Unit VI: Closed loop control technique:

Motor transfer function-P, PI and PID controllers, current control-Design procedure, phase locked loop (PLL) control-microcomputer control. Industrial applications and modern trends in drive, effect of RMS voltage variation on drive behavior. (8Hrs)

Text Books:

1. B. K. Bose, “Modern Power Electronics and AC drives”, Pearson Education, Asia, 2003.
2. M. H. Rashid, “Power Electronics”, Third Edition, PHI
3. G. K. Dubey, “Fundamentals of Electrical Drives”, Narosa Publishing house.

Reference Books:

1. V. Subrahmanyam, “Electric Drives-Concepts and Applications”, TMH
2. G. K. Dubey, “Power Semiconductor controlled drives”, PH 1989.
3. R. Krishnan, “Electric Motor Drives: Modeling, Analysis and Control”, PH, 1998.
4. P. Vas, “Sensor less vector and direct torque control”, Oxford Press, 1998.
5. W. Leonard, “Control of Electric Drives”, Springer Verlag, 1985.

603102: SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL

Teaching Scheme:
Theory: 4Hrs/Week
Credits: 4

Examination Scheme:
In-Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks

Perquisites: Modern Control Theory, Signals and Systems, Digital Control / DSP, Random variables

Course Objectives: Course objectives are to

- ✓ Introduce students to the fundamentals of system identification
- ✓ Provide the students with the theoretical background for developing various linear models of dynamic systems
- ✓ Impart an understanding of the various techniques in obtaining model estimates.
- ✓ Provide the students with the tools necessary for analyzing the quality of experimental data and evaluating the performance of candidate model structures
- ✓ Familiarize the students with Adaptive Control and Model Predictive Control.

Course Outcomes: Upon successful completion of this course, the student will be able to

- ✓ Apply the principles in system identification
- ✓ Understand the basic properties/limitations of different identification techniques
- ✓ Utilize various methods of estimating the system parameters iteratively.
- ✓ Distinguish between various types of learning mechanisms
- ✓ Make use of different methods for prediction.
- ✓ Demonstrate an understanding of various control techniques that require parameter identification.

Unit I: Introduction to Identification techniques

System Identification basic concepts, persistently exciting input, input signals, persistent excitation, Nonparametric Methods: Transient analysis, Frequency Analysis, Correlation Analysis and Spectral Analysis , Various types of Model structure (ARMAX, BoxJenkins, OEmodels etc.) , Least Square Estimation, Levinson Algorithm, Recursive Estimation (8 Hrs)

Unit II:

Parameter estimation using prediction error method and instrumental variable method, maximum likelihood estimation, Convergence and Consistency, Model Validation. (8Hrs)

Unit III:Kalman Filter

State model for a continuous process with measurement and process noise, Kalman Filter as a state estimatior, Discrete state model , Discrete time Kalman Estimator, Prediction as filtering. (8Hrs)

Unit IV: Learning Systems and Methods

Learning and pattern recognition, Parametric and non parametric training methods, Linear discreminant function, Learning systems with and without supervision, Decision theoretic methods, Bayesian learning. (8Hrs)

Unit V: Introduction to Adaptive Control, Effects of Process Variations, Various Adaptive Schemes, the MIT Rule, Determination of the Adaptation Gain, Lyapunov Theory, Design of MRAS Using Lyapunov Theory (8Hrs)

Unit VI: Model Predictive Control:

MPC strategy, MPC elements, Objective function, Obtaining control law, Different MPC algorithms (8Hrs)

Reference Books:

- T. Soderstrom& P. Stoica, “System Identification”, Prentice Hall
- L.Ljung, “System Identification Theory for the user”, Prentice Hall, 1999.
- Astrom K. J., Wittenmark B - "Adaptive Control", Addison Wesley, 1995.
- M. S. Grewal, A.P. Andrews,”Kalman Filtering: Theory and Practice Using MATLAB”, Second Edition, John Wiley & Sons, 2001
- E. Camacho and C. Bordons, ”Model Predictive Control in the Process Industry”, Springer,1995.
- Mendel, J.M. and Fu, K. S. "Adaptive Learning and Pattern Recognition Systems", Academic Press, New York, 1970.
- Papoulis, “Probability, Random Variables and stochastic processes”, 2nd Ed., McGraw Hill, 1983.

603103: (ELECTIVE III)

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/week	Paper		TW	Oral / Presentation	Total	
603103		In semester Assessment	End Semester Assessment				
	5	50	50	--	--	100	5

Code No.	Module I(Credit 4) (Select any one)	Code No.	Module II(Credit 1) (Select any one)
603103 M-I (i)	Intelligent Control	603103 M-II (i)	Artificial Intelligent tools
603103 M-I (ii)	SCADA Systems and Applications	603103 M-II (ii)	Intelligent Sensors and instrumentation
603103 M-I (iii)	Computer Aided Control System Design	603103 M-II (iii)	Human Rights
--	--	603103 M-II (iv)	Green building design
--	--	603103 M-II (v)	MEMS and Applications

603103 M-I (i): INTELLIGENT CONTROL

Teaching Scheme:
Lectures: 4 Hrs./ Week
Credits: 4

Examination Scheme:
In-Semester Assessment: 25
End Semester Assessments: 50

Prerequisites: Students should have gone through mathematics, mechanics, control system-I and microcontroller and its programming.

Course Objectives: Course objectives are to

- ✓ Be familiar with the automation and brief history of robot and applications.
- ✓ Acquire the knowledge on advanced algebraic tools for the description of motion.
- ✓ Give the student familiarities with the kinematics of robots.
- ✓ Give knowledge about robot end effectors and their design.
- ✓ Give knowledge about various Sensors and their applications in robots
- ✓ Develop the ability to analyze and design the motion for articulated systems.

Course Outcome: After the successful completion of this course, the student will be able to:

- ✓ Explain various intelligence tools to evaluate complex and real life electrical problems.
- ✓ Explain basics of fuzzy logic and compare with crisp logic.
- ✓ Design and implement various fuzzy logic model and inference systems
- ✓ Apply various fuzzy logic technologies for real life problem to control various parameters.
- ✓ Understand artificial neural network for controlling nonlinear systems.
- ✓ Design and implement ANN model for various applications.

Unit I: Introduction to intelligent systems **[8 Hrs]**

Humans and Computers; Basic Principles in Expert Systems, genetic algorithm, artificial neural network, fuzzy logic, ant colony algorithm, particle swarm optimization; Advantages and applicability of intelligent tool for specific task.

Unit II: Fuzzy Logic **[8 Hrs]**

Fuzzy versus crisp; Crisp sets; crisp relations: Cartesian product; operation and relations; Fuzzy sets: membership function; Basic fuzzy set operations; properties of fuzzy sets; fuzzy relations: Fuzzy Cartesian product; operation on fuzzy relations.

Unit III: Fuzzy Modelling and Control **[8 Hrs]**

Laws on prepositional logic; Inference in prepositional logic; predicate logic: Interpretation of predicate logic formula; Inference in predicate logic; fuzzy logic: Fuzzy quantifiers; fuzzy Inference; fuzzy rule based system; de-fuzzification methods.

Unit IV: Applications on Fuzzy Logic control **[8 Hrs]**

Fuzzy logic application: Greg viot's fuzzy cruise controller; Air conditioner controller. Detection and elimination of a potential fire in engine and battery compartments of hybrid electric vehicles; temperature controller; Antilock break system (ABS) using Fuzzy logic.

Unit V: Neural Networks and Control **[8 Hrs]**

Biological Neuron; Artificial Neuron Models; Essentials of Artificial Neural Networks: Artificial Neuron Model; Operations of Artificial Neuron; Learning Strategy: Supervised; Unsupervised; Reinforcement; Learning Rules. Perceptron Models: Multilayer feed forward Neural Networks. Generalized Delta Rule; Back propagation Training; Associative Memory; Hebbian Learning; Hamming Network; Bi-directional Associative Memory (BAM) Architecture and Adaptive Resonance Theory (ART).

Unit VI: Applications on Neural Network **[8 Hrs]**

General models of ANN Applications; Pattern recognition, control and Process Monitoring; fault diagnosis; load forecasting; ANN structures with feed-back loops such as recurrent net can be used to model dynamic systems where state information is used; Energy price prediction.

Text Books:

1. “Neural Network Design” by Hagan, Demuth, Beale- Thomas Learning, Vikas Publishing House
2. “Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications” by Rajasekharan and Rai - PHI Publication.

Reference Books:

1. Neural and Fuzzy Systems: Foundation, Architectures and Applications, - N. Yadaiah and S. BapiRaju, Pearson Education
2. Neural Networks - James A Freeman and Davis Skapura, Pearson, 2002.
3. Neural Networks - Simon Hykins, Pearson Education
4. Neural Engineering by C. Eliasmith and CH. Anderson, PHI

603103 M-I (ii): SCADA SYSTEMS AND APPLICATIONS

Teaching Scheme:
Lectures: 4 Hrs./ Week
Credits: 4

Examination Scheme:
In-Semester Assessment: 25
End Semester Assessments: 50

Prerequisites: PLC and SCADA at undergraduate level, Ladder diagram logic

Course Objectives: Course objectives are to
- ✓ Introduce SCADA communication topologies
- ✓ Make aware of SCADA system components
- ✓ Understand application of SCADA in power systems

Course Outcome: After the successful completion of this course, the student will be able to:
- ✓ Explain interfacing of SCADA and PLC
- ✓ List out SCADA system components
- ✓ Describe SCADA architecture
- ✓ Explain use of SCADA system in power system operation and control

Unit I: Introduction to SCADA and PLC:
SCADA: Data acquisition system, evaluation of SCADA, communication technologies, monitoring and supervisory functions.PLC: Block diagram, programming languages, Ladder diagram, Functional block diagram, Applications, Interfacing of PLC with SCADA.
(8 Hrs)

Unit II: SCADA system components:
Schemes, Remote Terminal Unit, Intelligent Electronic Devices, Communication Network, SCADA server.
(8Hrs)

Unit III: SCADA Architecture
Various SCADA Architectures, advantages and disadvantages of each system, single unified standard architecture IEC 61850 SCADA / HMI Systems.
(8Hrs)

Unit IV: SCADA Communication
Various industrial communication technologies- wired and wireless methods and fiber optics, open standard communication protocols.
(8Hrs)

Unit V: Operation and control of interconnected power system
Automatic substation control, SCADA configuration, Energy management system, system operating states, system security, state estimation. (8Hrs)

Unit VI: SCADA applications

Utility applications, transmission and distribution sector operation, monitoring analysis and improvement. Industries oil gas and water. Case studies, implementation, simulation exercises.

(8Hrs)

Text Books:

- Stuart A Boyer: SCADA supervisory control and data acquisition, International Society of Automation, 2010
- Gordan Clark, Deem Reynders, Practical Modem SCADA Protocols

Reference Book:

- Sunil S. Rao, Switchgear and Protections, Khanna Publishers.

603103 M-I (iii): COMPUTER AIDED CONTROL SYSTEM DESIGN

Teaching Scheme:
Lectures: 4 Hrs./ Week
Credits: 4

Examination Scheme:
In-Semester Assessment: 25
End Semester Assessments: 50

Prerequisites: Linear systems theory, basic control systems, modern control theory, PID controls

Course Objectives: Course objectives are to

- ✓ Introduce application of software for control system design
- ✓ Develop the control logic and implement in the software for control purpose
- ✓ Design controller using digital techniques and algorithms

Course Outcome: After the successful completion of this course, the student will be able to:

- ✓ Explain use of software for control system design
- ✓ Use conventional design methods using computer programming
- ✓ Employ MATLAB for designing controller using modern control theory
- ✓ Tune PID controllers using software programming for particular system/process

Unit I: Introduction

Application of software and simulink for control system design. Review of compensation technique and choice of optimum parameters to obtain desired performance. Absolute stability and relative stability concepts. (8Hrs)

Unit II: Design of Linear Control Systems

Transient and steady state response; Polar, Bode, Root locus plots; Reshaping of these plots to obtain desired response, Initial condition and forced response.

(8Hrs)

Unit III: Design of control systems by state variable techniques

Controllability, Observability; Stability by using computer methods; solution of state and output equations of closed loop systems. Pole placement design, Full and reduced order observers, Linear Regulator problem, Quadratic performance Criterion. (8Hrs)

Unit IV: Design of nonlinear control systems

Phase plane technique, Describing Function method for nonlinearities like saturation, dead space, ON/OFF nonlinearities. Simulation techniques. (8Hrs)

Unit V: PID Controller

Tunable PID controller, Ziegler – Nichol’s method, Simulation of multi-loop control system using P, PI, PID controller and finding the system response. Standard compensator structures: P, PI and PID control. (8Hrs)

Unit VI: Design of digital control system

Technique and methodology; Computation of digital equivalent of the analog controller, simulation and performance. Digital controller design, Regulator and observer design. (8Hrs)

Text Books:

- G. C. Goodwin, S. F. Graebe, M. E. Salgado, “Control System Design”, Prentice Hall of India
- Norman S. Nise, “Control Systems Engineering”, 3rd Edition, Wiley
- George Ellis, “Control System Design Guide – A Practical Guide”, 3rd Edition, Academic Press

Reference Books:

1. M. Gopal, “Digital Control and State Variable Method”, Tata McGraw Hill
2. HadiSaadat, “Computational Aids in Control System Using MATLAB”, McGraw Hill International
3. Ogata K., “Modern Control Engineering”, 4th Edition, Prentice Hall
4. Ogata K. “System Dynamics”, 3rd Edition, Prentice Hall
5. M. Gopal, “Control Systems Principles and Design”, Tata McGraw Hill

603103 M-II (i): ARTIFICIAL INTELLIGENT TOOLS

Teaching Scheme:
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme:
In-Semester Examination: 25 Marks

Course Objectives: Course objectives are to

- ✓ Introduce artificial intelligence techniques basics and design aspects
- ✓ Make use of these techniques for control design purpose

Course Outcomes: Upon successful completion of this course, the student will be able to

- ✓ Model and design control scheme using fuzzy logic.
- ✓ Apply genetic algorithm in power system optimization problem.

Unit I: Fuzzy Logic System

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning.Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification.

Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Selforganizing fuzzy logic control. Case studies and assignment based on applications of fuzzy logic. [7 Hrs]

Unit II: Genetic Algorithm

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters.Concept on some other search techniques like tabu search and and-colony search techniques forsolving optimization problems. GA application to power system optimization problem, Casestudies: based on use of GA for optimization. [7 Hrs]

Text Books:

1) M. Ganesh “Introduction to Fuzzy Sets and Fuzzy Logic”, Prentice Hall, India.
2) Zimmerman H.J. "Fuzzy set theory-and its Applications"-Kluwer Academic Publishers, 1994.

Reference Books:

1) KOSKO B. "Neural Networks And Fuzzy Systems", Prentice-Hall of India Pvt. Ltd., 1994.
2) KLIR G.J. & FOLGER T.A. "Fuzzy sets, uncertainty and Information", Prentice-Hall of India Pvt. Ltd., 1993.
3) Driankov, Hellendroon, "Introduction to Fuzzy Control", Narosa Publishers.

603103 M-II (ii): INTELLIGENT SENSORS AND INSTRUMENTATION

Teaching Scheme:
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme:
In-Semester Examination: 25 Marks

Course Outcomes: Upon successful completion of this course, the student will be able to

- ✓ Design sensors and transducer for measurement of electrical and non electrical quantities and convert signals into analog or digital form.
- ✓ Distinguish between primary sensors, IC technologies, micro and nano sensors.

Unit I: Introduction
Sensors: primary sensing principles and measurement variables, sensor performance characteristicsand terminology. Instrumentation: transducer measurement circuit, signal conditioning circuit,Data conversion: DAC, ADC, virtual instrumentation with Lab View.

[7 Hrs]

Unit II: Smart Sensors
Primary sensors; excitation; compensation; information coding/ processing; data communication;standards for smart sensor interface. Recent trends in sensor technologies: Introduction; filmsensors (thick film sensors, thin film sensors); semiconductor IC technology standard methods;Micro Electro-Mechanical Systems (micro-machining, some application examples); nanosensors.

[7 Hrs]

Text books:
1) Barney, G. C., "Intelligent Instrumentation", Prentice Hall, 1995.
2) D. Patranabis, "Sensors and Transducers", PHI, 2003.

Reference Book:
1. Alan S. Morris, "Principles of Measurement & Instrumentation", PHI Pvt. Ltd., 1999.

603103 M-II (iii):HUMAN RIGHTS

Teaching Scheme:
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme:
In-Semester Examination: 25 Marks

Course Objectives: Course objectives are to

- ✓ Generate awareness about human rights
- ✓ Develop knowledge of various facets of human rights

Course Outcomes: Upon successful completion of this course, the student will be able to

- ✓ Learn about policies, schemes and Constitution about Human rights
- ✓ Learn roles of various entities about human rights

Unit I:
Human Rights – Concept, Development, Evolution
- Philosophical, Sociological and Political debates, Benchmarks of Human Rights Movement.
Human Rights and the Indian Constitution
- Constitutional framework, Fundamental Rights & Duties, Directive Principles of State Policy
- Welfare State & Welfare Schemes
Human Rights & State Mechanisms
- Police & Human Rights, Judiciary & Human Rights, Prisons & Human Rights
- National and State Human Rights Commissions [7 Hrs]

Unit II:
Human Rights of the Different Sections and contemporary issues
- Unorganized Sector, Right to Environment,Globalization and Human Rights
- Right to Development,
Citizens' Role and Civil Society
- Social Movements and Non-Governmental Organizations, Public Interest Litigation
-Role of Non Government organizations in implementation of Human rights.
- Right to Information
Human Rights and the international scene –Primary Information with reference to Engineering, Industry
- UN Documents
- International Mechanisms (UN & Regional)
- International Criminal Court [7Hrs]

References:

1) Study material on UNESCO,UNICEF web site
2) HUMAN RIGHTS IN INDIA A MAPPING, UshaRamanathan
Available at: http://www.ielrc.org/content/w0103.pdf
3) Introduction to International Humanitarian Law by Curtis F. J. Doebbler - CD Publishing , 2005.
4) Freedom of Information by Toby Mendel - UNESCO, 2008

603103 M-II (iv): GREEN BUILDING DESIGN

Teaching Scheme:
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme:
In-Semester Examination: 25 Marks

Course Objectives: Course objectives are to

- ✓ Establish the familiarity of green building for sustainability
- ✓ Promote energy efficiency through green building design

Course Outcomes: Upon successful completion of this course, the student will be able to

- ✓ Learn green and sustainable design techniques for both commercial and residential buildings.
- ✓ Design water, lighting, energy efficiency plan using renewable energy source.

Unit I: Sustainability and Building design
Sustainability, objectives of sustainable development, Sustainable aspects of habitat design,sustainable buildings, principles, approaches and characteristics, climate data, climate parametersand zones, comparative analysis of various climatic zones, site planning recommended check listfor identifying site characteristics, site development and layout. Efficient water management andwaste water treatment, solid waste management. [7 Hrs]

Unit II: Energy efficiency
Solar passive techniques in building design to minimize load on conventional system i.e. heating,cooling, ventilation and lighting. Designing Energy efficient lighting and HVAC systems. Use ofrenewable energy system to meet part of building load. Green building certification. Overviewvarious green building in India. Policy and regulatory mechanism. [7 Hrs]

Text Book :
Seven wonders of Green Building Technology- Karen Sirvaitis, Twenty first century books.

References:

1. Sustainable Building Design Manual, Volume 2, TERI, New Delhi
2. Energy Efficient Buildings in India, TERI, New Delhi
3. Sustainable Building Design Manual, Volume 1 TERI, New Delhi

603103 M-II (v): MEMS AND APPLICATIONS

Teaching Scheme
Lectures: 1Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination: 25 Marks

Course Objectives: Course objectives are to
- ✓ Provide knowledge of different terms related to MEMS
- ✓ Offer information of various sensors and actuators and their uses.

Course Outcomes: Upon successful completion of this course, the student will be able to
- ✓ Explain characteristics of MEMS.
- ✓ Understand use of MEMS in actuators and sensors.

Unit I: Introduction
Characteristics of MEMS, energy domains and transducers, sensors and actuators, Introduction to micro fabrication, silicon based MEMS processes, new materials, and review of electrical and mechanical concepts in MEMS, semiconductor devices, stress and strain analysis. [7 Hrs]

Unit II: Sensors and Actuators
Electrostatic sensors – parallel plate capacitors – applications – thermal sensing and actuation – thermal expansion – thermal couples – thermal resistors – applications – magnetic actuators – micro magnetic components – case studies of MEMS in magnetic actuators.
Piezo-resistive sensors and piezoelectric sensors – sensor materials - applications to inertia, pressure, and flow. [7 Hrs]

Textbook:

1. Chang Liu, "Foundations of MEMS', Pearson Education Inc., 2006.

Reference Books:

1. NadimMaluf, "An Introduction to Micro Electro Mechanical System Design", Artech house, 2000.
2. Mohamed Gad-el-hak, "The MEMS Handbook", CRC Press, 2000
3. Tai Ran Hsu, "MEMS and Micro Systems Design and Manufacture" Tata McGraw Hill, new delhi, 2002.
4. Julian W. Gardner, Vijay K. Varadan, Osama O. Awadelkarim, "Micro Sensors, MEMS and smart devices", John Wiley & Sons Ltd., 2002
5. James J. Allen, "Micro Electro Mechanical System Design", CRC Press Published in 2005.

603104: SEMINAR– II

Teaching Scheme	**Examination Scheme**
4 Hrs / week	Term work: 50 Marks
Credits: 04	Oral/ Presentation: 50Marks

Seminar II shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization and based on broader area of interest to facilitate to proceed for dissertation work, selected by him/her approved by the guide and authority. He/she should study basic theory related to the topic from standard references. A student is expected to perform the exhaustive literature review of the topic. The student should focus on understanding the state of art concept, literature published at standard platforms to enable the finalization of objective of his/her ME dissertation. A guide should maintain weekly record of discussion related to the topic. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and head of the department/institute.

603105: PROJECT STAGE - I

Teaching Scheme	**Examination Scheme**
8Hrs / week	Term work: 50 marks
Credits: 08	Oral: 50 Marks

Project work Stage – I is an integral part of the project work. In this, the student shall complete the partial work of the project which will consist of problem statement, literature review, project overview, scheme of implementation (Mathematical Model/block diagram/ PERT chart, etc.) simulation model, Layout & Design of the Set-up and results if obtained. As a part of the progress report of Project Stage-I, the student shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic. The project stage I is the progress presentation of dissertation work. The student should clearly present different stages in which dissertation work is to be completed, giving planning of the remaining part to be completed in Project Stage-II. Publication based on the work is desirable in the reputed national or international journal or in the proceedings of reputed and reviewed conferences. A guide should maintain record of discussion related to the topic, work carried out by the student. The student shall submit the duly certified progress report of Project work Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department / Institute.

Semester IV

603106: SEMINAR- III

Teaching Scheme	**Examination Scheme**
5 Hrs / week	Term work: 50 Marks
Credits: 05	Oral/ Presentation: 50Marks

Seminar III shall preferably be an extension of seminar II. The content of report of seminar III will include development of the work till date along with relevant theory. A guide should maintain record of discussion related to the topic, work carried out by the student, action taken etc. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

603107: PROJECT WORK STAGE - II

Teaching Scheme	**Examination Scheme**
20 Hrs / week	Term work: 150 marks
Credits: 20	Oral: 50 Marks

In Project Work Stage – II, the student shall complete the remaining part of the project which will consist of simulation, fabrication of set up required for the project, work station, conducting experiments and taking results, analysis & validation of results and conclusions. A student must publish minimum one paper based on the dissertation work in the reputed national or international journal or in the proceedings of reputed and reviewed conferences. Details of this publication should be mentioned in the final report. The dissertation work of candidate would be evaluated by the guide as well as panel of internal/external experts, before submitting it to the university so as to ensure basic minimum quality standard. A proper record of this evaluation is needed to be maintained. A guide should maintain record of discussion related to the topic, work carried out by the student, action taken etc. The student shall prepare the duly certified final report of project work in standard format for satisfactory completion of the work by the concerned guide, head of the Department and head of the Institute.