STRUCTURE FOR

M.E. ELECTRICAL (CONTROL SYSTEMS) PROGRAMME

UNDER FACULTY OF ENGINEERING

EFFECTIVE FROM JUNE 2013

UNIVERSITY OF PUNE

THE SYLLABUS IS PREPARED BY :

BOS- Electrical Engineering,

University of Pune.

PEER REVIEW BY :

- Prof. Dr. Mrs. G.A. Vaidya, (Chairman)
- Dr.J.G.Ghodekar,
  Ex-Dean FOE, Shivaji University, Kolhapur
- Shri Jayant Badve, (Expert from Industry)

Structure for M.E. (Electrical) Control Systems 2013 Course

SEMESTER I

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Lect./ Pr	Paper		TW	Oral / presentation	Total	
			In Semester Assessment	End Semester Assessment				
503101	Computational Technique for Control System	4	50	50	-	-	100	4
503102	Process Control Management	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	System Identification and Adaptive Control	4	50	50	-	-	100	4
503109	Advanced Digital Control Techniques	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	Computer Aided Control System Design	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	08	-	-	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 Work Stage II	20	-	150	50	200	20
Total		**25**	**-**	**200**	**100**	**300**	**25**

List of Elective Subjects

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

Elective-I (5 credits)		**Elective-II (5 credits)**		**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)
1) Automation and Robotics	1) Project Management	1) Robust Control Systems	1) Electric Vehicles	1) Intelligent Control	1) Artificial Intelligent tools
2) Modeling of Dynamic System	2) IPR and Patent Law	2) Large Scale Systems	2) Fundamentals of Cyber Security	2) SCADA Systems and Applications	2) Intelligent Sensors and instrument-ation
3) Industrial Automation and control	3) Technical communication	-	3) Disaster management	-	3) Human Rights
-	4) Smart Grid Technologies	-	4) Communication protocols in SCADA System	-	4) Green building design
-	-	-	5) Mechatronics	-	5) 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 1 - 4		**End semester assessment**	
Class tests	30 Marks	Units 1- 4	18 Marks
Assignments / Mini Project	20 Marks	Unit 5	16 Marks
		Unit 6	16 Marks
Total	50 Marks	Total	50 Marks

B) Elective subjects: Credits 5

Total marks: 100

Module 1 (Credits – 4)			
In semester assessment Units 1-4		**End semester assessment**	
Class tests	15 Marks	Units 1 & 2	12 Marks
Assignments/PPT presentation	10 Marks	Units 3 & 4	14 Marks
		Unit 5	12 Marks
		Unit 6	12 Marks
Total	25 Marks	Total	50 Marks

Module 2 (Credit – 1)	
In semester assessment	Units 1-2
Class tests / Assignments	25 Marks

Chairman
B.O.S.
Electrical Engineering

503101: COMPUTATIONAL TECHNIQUES FOR CONTROL SYSTEMS

Teaching Scheme
Theory: 4Hrs/Week
Credits:04

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

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. (6 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.

(6 Hrs.)

Unit III: Linear Programming

Linear programming problems, LP problems, involving LE constraints, simplex method, revised simplex method, duality.

(6Hrs.)

Unit IV: Nonlinear Programming

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

(6 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.

(6 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.

(6 Hrs.)

Text Book:

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

Reference Books:

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

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

503102: PROCESS CONTROL MANAGEMENT

Teaching Scheme
Theory: 4 Hrs/Week
Credits:04

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

Unit I: Management Process
Motivation- Motives, classification of motives. Leadership – definition, importance – leadership style - models and theories of leadership styles. Group dynamics and teams, theories of group formation, formal organization and informal groups and their interaction. Conflict management, stress management, strategies for solving destructive conflicts.

(6 Hrs.)

Unit II: Process Dynamics
Introduction to Process Control, Control Strategies, control Objectives, Benefits of Control, and importance of Control Engineering. Mathematical Modeling Principles - A Modeling Procedure, Modeling examples, Linearization. Dynamic behavior of typical process systems - Series structure of a simple systems, Parallel structure of a simple systems, Recycle structure, Staged processes, multiple-Input multiple-output systems, an empirical model building, process reaction curve.

(6 Hrs.)

Unit III: Feedback Control and PID Controller for Process Management
Process and Instrument Elements of the Feedback Loop, Block Diagram, Control Performance Measures for Common Input Changes, Selection of Variables for Control. PID Controller Tuning for Dynamic Performance - Determining Tuning Constants for Good Control Performance, Ziegler-Nichols method, Correlations for Tuning Constants, Fine-Tuning the Controller Tuning Constants, Controller tuning based on stability –Dead beat and self tuning controller, some important interpretations.

(6 Hrs.)

Unit IV: Digital Implementation and Management of Process Control
Structure of the Digital Control System, Effects of Sampling a continuous signal, The Discrete PID Control Algorithm, Effects of Digital control on stability, Tuning and performance. Practical Application of Feedback Control - Equipment Specification, Input Processing, Feedback Control Algorithm, Output Processing.

(6 Hrs.)

Unit V: Cascade Control and Feed forward Control
Design Criteria, Cascade control,Feed-forward Performances, Controller Algorithm and Tuning, Implementation Issues. (4 Hrs.)

Unit VI: Multivariable Control
Modeling and Transfer Functions, Influence of interaction on the Possibility of Feedback Control, Process Interaction - Important Effects on Multivariable System Behavior, Process Interaction - The Relative Gain Array (RGA), Effect of Interaction on Stability and Tuning of Multi loop Control Systems. Typical multivariable process control system.

(8 Hrs.)

Text Books:

1. T E Marlin – "Process Control - Designing processes and Control system for dynamic performance", McGraw-Hill, International Edition, New York 1995.

2. G. Stephanopoulos: "Chemical process control – An introduction to Theory & Practice", Prentice Hall of India Ltd, New Delhi.

Reference Books:

1. Organization behavior, 9th Ed. – Stephen Robbins San Diego State University Prentice Hall International, Inc.

2. Human behavior at work – Davis and Newstorm , McGraw-Hill/Irwin Publications
3. Organization behavior – Uma Sekaran, Tata McGraw-Hill Publications

503103: NON LINEAR CONTROL SYSTEMS

Teaching Scheme
Theory: 4 Hrs/Week
Credits: 04

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

Unit I: Introduction to Non Linear System
Classification of non-linearity's, types of non-linearity in physical system, Peculiarities of nonlinear systems, methods of analysis of non-linear systems and comparison.
(6 Hrs.)

Unit II: 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. (6 Hrs.)

Unit III: Describing Function Method
Describing function, DF of typical nonlinearities, stability analysis using DF method, pole zero shifting transformation, Circle criterion, Popov criterion.
(6 Hrs.)

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

Unit V: 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 VI: Sliding Mode Control
Feedback linearization, Input Output linearization, Concept of sliding mode control, Nonlinear control system design using sliding mode technique. (4 Hrs.)

Text Books:
- Automatic Control System: George J. Thaler Brown, Jaico Publications
- Nonlinear Systems: Hasan A. Khalil, Prentice Hall of India

Reference Books:
- Control Systems Theory and Application: Samarjit Ghosh, Pearson Education
- Principle and Design of Control Systems, M. Gopal. Tata McGraw-Hill Education, 2002
- Introduction to Control Engineering: A. K. MandaI, New Age International Publications
- Nonlinear Systems: Analysis, Stability & Control, S.S. Sastry, Springer Verlag, New York, 1999.

503104 : RESEARCH METHODOLOGY

Teaching Scheme
Lectures: 4 Hours / Week
Credits: 4

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

Unit I:
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.
[8 Hrs]

Unit II:
Research Formulation – Defining and formulating the research problem -Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.Summarizing a Technical Paper - summary template
Online tools - Google, CiteSeer, ACM Digital Library, IEEE, The on-line Computer Science bibliography, Searching patents
[8 Hrs]

Unit III:
Research design, sampling design and scaling techniques – Research design – Basic Principles- Need of research design — Features of good design – Important concepts relating to research design, basic principles of experimental designs, implications of sample design, steps in sample design, criteria of selecting sampling procedure, characteristics of good sampling design, different types of sample design. Scaling techniques: measurement scales, sources of error, technique of developing measurement tool, important scaling techniques, scale construction techniques.
[8 Hrs]

Unit IV :
Data Collection and analysis:- Observation and Collection of primary and secondary data - Methods of data collection, processing operations, types of analysis, statistics in research, measures of central tendency, measures of dispersion, measures of asymmetry, measures of relationships, simple regression analysis, multiple correlation and regression, partial correlation.
[8 Hrs]

Unit V:
Reporting and thesis writing – 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 – Illustrations and tables - Bibliography, referencing and footnotes - Oral presentation – Planning – Preparation –Practice – Making presentation – Use of visual aids - Importance of effective communication - Documentation and presentation tools: LATEX.
[8 Hrs]

Unit VI:

Types of technical papers - Journal papers, Conference papers, Survey papers, Poster papers, Review papers Comparison, Structure of a survey, conference and journal paper, Organization and flow of thesis/ Project report, Research proposal: preparation, budgeting, presentation, funding agencies for engineering research, Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights. [8 Hrs]

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

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.

503105 (ELECTIVE – I)

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

Code No.	Modules of 4 credit (Select any one)	Code No.	Modules of 1 credit (Select any one)
503105 M1(i)	Automation and Robotics	503105 M2(i)	Project Management
503105 M1(ii)	Modeling of Dynamic System	503105 M2(ii)	IPR and Patent Law
503105 M1(iii)	Industrial Automation and control	503105 M2(iii)	Technical communication
-	-	503105 M2(iv)	Smart Grid Technologies

503105 M1(i) : AUTOMATION AND ROBOTICS

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

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination:50 Marks

Unit I: Introduction
Basic concept of automation, types of automation: fixed, flexible and programmable and their comparative study. Robotics, definition, laws of Robotics, Introduction to NC and CNC machines - Basic concept, block diagram difference and comparison with robots, advantages, disadvantages and applications. Robot like devices such as prostheses, exoskeletons, telecherics, locomotive mechanism, robot manipulator, Concept of Workcell, 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.
(6 Hrs.)

Unit II: Fundamentals of Robot Technology
Basic structure, links and Joints, types of Joints, types of links, types of end effectors: Grippers: Mechanical, Vacuum cups, Magnetic, adhesive and miscellaneous. Tools as end effectors. Wrist configuration: concept of: yaw, pitch and roll.
Robot classification: according to 1) Co-ordinate system: Cartesian, cylindrical, spherical, SCARA, Articulated 2) Control Method: Servo controlled and non-servo controlled, their comparative study 3) Form of motion: P-T-P (point to point), C-P (continuous path), pick and place etc. and their comparative study 4) Drive Technology: Hydraulic, Pneumatic, Electric (stepper motor, D.C. servo motor) in detail with selection criteria. Motion conversion: Rotary to rotary, rotary to linear and vice versa. (6 Hrs.)

Unit III: Industrial Applications and Robot Programming
Industrial Applications of Robots: Welding, Spray-painting, Grinding, Handling of rotary tools, Parts handling/transfer, Assembly operations, parts sorting, parts inspection, Potential applications in Nuclear and fossil fuel power plant etc. (Details for the above applications are selection criterion of robots, sensors used, selection of drives and actuators, methods of control, peripheral devices used etc) Programming of Industrial Robots: Concept of on-line and off line programming, concept of teach pendant, three levels of robot programming such as 1) Specialized manipulation languages 2) Robot library for an existing computer language 3) Robot library for a new general purpose language. Classification of robot specific languages on the basis of hardware level, point-to-point level, the motion level and structured programming level.
(6 Hrs.)

Unit IV: Robot arm dynamics and transformation
Newton Euler Equations, Kinetic and potential energy, Lagrangian analysis for a single prismatic joint working against gravity and single revolute joint. Joint vector, Homogeneous co-ordinates. Matrix operators for translation and rotation. Homogeneous transformation matrix. Concept of "Hand Matrix". Effect of pre and post multiplication of a hand matrix by basic matrix operators.
(6 Hrs)

Unit V: Kinematics
Denavit-Hartenberg (D-H) representation of kinematics chains. Rules for establishing link co-ordinate frames. D-H matrix. Forward solution of robotic manipulator. Examples of forward solutions for Stanford and PUMA robots.

Inverse Kinematics: Inverse (back) solution by i) direct approach, ii) Geometric approach, iii) Geometric approach with co-ordinate transformation and iv) manipulation of symbolic T and A matrices.

(6 Hrs.)

Unit VI: Robot Control

Open loop and closed loop control, Linear control Schemes, PI and PID controllers, Torque and Force control of robotic manipulators, Adaptive control, Hybrid control, Impedance control. Manipulator Jacobian, Jacobian for prismatic and revolute joint. Jacobian Inverse, Singularities. Control of Robot manipulator: joint position controls (JPC), Resolved Motion Position Controls (RMPC) and Resolved Motion Rate Control (RMRC). (6 Hrs.)

Text Books:

- Richard D. Klafter, Thomas A. Chemielewski, Michael Neign "Robotic Engineering – An Integral Approach", Prentice Hall of India Pvt. Ltd., New Delhi. Eastern Economy Edition.
- K. S. Fu., R. C. Gonzalez, C. S. G. Lee, "Robotics: Control Sensing, Vision and Intelligence", International Edition, McGraw Hill Book Co.
- R. K. Mittal, I. J. Nagrath, "Robotics and Control", Tata McGraw Hill Publishing Company Ltd., New Delhi.

Reference Books:

- Arthur J. Critchlow, "Introduction to Robotics" , Macmillan Publishers Limited, 1985.
- Robert J. Schilling, "Fundamentals of Robotics: Analysis and Control", Prentice Hall of India, New Delhi.
- John J. Craig, "Introduction to Robotics: Mechanics and Control", Pearson Education.
- Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, "Industrial Robotics: Technology, Programming and Applications", McGraw Hill Book Company.

503105 M1(ii) : MODELING OF DYNAMIC SYSTEM

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

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination:50 Marks

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.

(5 Hrs)

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. (6 Hrs)

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. (7 Hrs)

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. (6 Hrs)

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.

(5 Hrs)

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. (7 Hrs)

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

Reference Books:
- Simulation Modeling and Analysis: Averill M. Law, W. David Kelton. McGraw Hill

- System Dynamics: Modeling Analysis, Simulation, Design: Ernest O. Dobling, Marcel Dekker Inc.

- Modeling of Dynamical Systems Vol. I: H. Nicholson (Editor), Peter Peregrinus Ltd., on behalf of IEE (Useful for unit 6) 116842, 1980 Edition

- Dynamic Modeling and Control of Engineering Systems: J. Lowen Sheaser, Bohan T. Kulawski Macmillan Publishing Company NY, 158275, 1990 Edition

503105 M1(iii) : INDUSTRIAL AUTOMATION AND CONTROL

Teaching Scheme
Lectures: 4 Hr/Week
Credits:4

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination:50 Marks

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. Kok Kiong "Drives and Control for Industrial Automation", Springer

503105 M2 (i) : PROJECT MANAGEMENT

Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination : 25 Marks

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 and assessment of risk, Sources of risks. Risk: - Adjusted discount rate method, certainly equivalent method, 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 M2 (ii) : IPR AND PATENT LAW

Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit I :
Intellectual property, History, Types(Seven types of Intellectual Property Right**s**) 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 non-obviousness, 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 the Common 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)
http://www.epo.org/law-practice/legal-texts/html/epc/2010/e/ar69.html
http://www.epo.org/law-practice/legal-texts/html/epc/2010/e/ar64.html
http://www.cas.go.jp/jp/seisaku/hourei/data/PA.pdf
http://nopr.niscair.res.in/bitstream/123456789/12687/1/JIPR%2016%285%29%20377-384.pdf

503105 M2 (iii) : TECHNICAL COMMUNICATION

Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination : 25 Marks

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, annexures, 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-principles 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, Massachusetts, second edition, 1994, ISBN 0-201-52983-1.

503105 M2 (iv) : SMART GRID TECHNOLOGIES

Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit: I

Need of Synchro phasor 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, PMU measurements and sampling rates State Estimation & observability by using PMU, phasor data use for real time operation, frequency stability monitoring and trending, power oscillation, voltage monitoring and trending. Alarming and setting system operating limits. Dynamic line rating and congestion management, outage restoration. Application of PMU for wide area monitoring and control. [9Hrs]

Unit: II

WAMS (Wind Area Measurement system): Architecture, Components of WAMS, GUI (Graphical User Interface), Applications: Voltage Stability Assessment, Frequency stability Assessment, Power Oscillation Assessment, Communication needs of WAMS, WAMPAC (Wide Area Monitoring Protection & Control), RAS (Remedial Action Scheme). Standards: IEEE 1344, IEEE C37.118 (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 improved situational awareness", Joseph Euzebe Tate, UMI Dissertation Publishing.
3. "Wide Area Monitoring, Protection and Control: The Gateway to Smart Grids", Fahd Hashiesh, 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-HILL EDITION.

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. ***Computational Techniques for 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. ***Process Control Management:***

a)To study the operation of Level transmitter, I/P converter and control valve.
b) To determine step response of 2^{nd} order system and calculate time domain specifications.
c) To study PI, PID controller for single loop feedback level control system.
d) To study the closed loop cascade level sensor/transmitter from supervisory station i.e. from computer.

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.

503107 : MULTIVARIABLE AND OPTIMAL CONTROL SYSTEMS

Teaching Scheme
Theory: 4 Hrs/Week
Credits: 4

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

Section I: Multivariable Control Systems

Unit I
Example of multivariable control systems, differential operator and transfer matrix, state-space models and system solution. (6 Hrs)

Unit II
Controllability, observability, state estimation, pole allocation, stability and reproducibility, minimal realization of multivariable control systems. (6 Hrs)

Unit III
Decoupling and model matching control., Extension of classical theory to Multivariable control systems. Design specifications for Multivariable Systems. (6 Hrs)

Section II: Optimal Control System

Unit IV
Hamiltonian formulation of optimal control problem, Hamilton-Jacoby equation, Linear regulator problem. Quadratic performance criterion, Numerical solution of Matrix Riccati Equation.. (8 Hrs)

Unit V
Pontryagin's minimum principle, application to optimal control of discrete and continuous systems. (5 Hrs)

Unit VI
Minimum time problems, Bang Bang Control, singular solutions. (5 Hrs)

Text Books:
- Linear Multivariable Control System: Y. S. Apte, New Age International Publication 1996
- Multivariable Control System: W. M. Wonham, Springer-Verlag, 1985
- Optimal Control- An Introduction: O. Kirk, Prentice Hall
- Optimum Systems Control: A. P. Sage, II Edition

Reference Books:
- Linear System Theory and Design: C. T. Chen, 3rd Edition, Oxford 1999
- Multivariable Control: N. K. Sinha, Marcel Dekker Inc., New York
- Control System Design: Goodwin, Graebe, Salgado
- Optimization Theory and Applications: S. Rao, Wiley Eastern

503108 : SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL

Teaching Scheme
Theory: 4 Hrs/Week
Credits: 4

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

Unit I: Introduction to Identification techniques
Basic concepts of Identification and Adaptive Control Systems.
Identification Techniques -

- Nonparametric Methods: Impulse Response and Correlation, Frequency Response, Fourier and Spectral Analysis, Need for Stochastic Identification.
- Parametric Methods: Least Square Estimation, Maximum Likelihood, Instrumental Variable Method
- Computation Methods: Levi son-type, Kalman- type and QR-type. (6 Hrs)

Unit II
Convergence and Consistency, Recursive Estimation, Bootstrapping, Experiment Design, Choice of Input, Model Structure and Order Determination, Model Validation, Practical Application.
(5 Hrs)

Unit III: Learning Systems and Methods
Learning in Redundant computer configuration, Learning and pattern recognition, Parametric and non parametric training methods, Linear discreminal function, Learning systems with and without supervision, Decision theoretic methods, Bayesian learning.
(6 Hrs)

Unit IV: Introduction to Adaptive Control and Real-Time Parameter Estimation
Introduction to Adaptive Control, Effects of Process Variations, Adaptive Schemes, Adaptive Control Problem Real-Time Parameter Estimation - Least Squares and Regression Models, Estimating Parameters in Dynamical Systems, Simulation of Recursive Estimation.
(6 Hrs)

Unit V: Self-Tuning Regulators (STR)
Pole Placement Design, Indirect Self-tuning Regulators, Continuous-Time Self-tuners, Direct Self-tuning Regulators, Disturbances with Known Characteristics, Stochastic Self-tuning Regulators, Unification of Direct Self-tuning Regulators, Linear Quadratic STR, Adaptive Predictive Control.
(6 Hrs)

Unit VI: Model-Reference Adaptive Systems (MRAS)
Introduction, The MIT Rule, Determination of the Adaptation Gain, Lyapunov Theory, Design of MRAS Using Lyapunov Theory, Bounded-Input, Bounded-Output Stability, Applications to Adaptive Control, Output Feedback, Relations between MRAS and STR, Nonlinear Systems.
(7 Hrs)

Text Books:

- Ljung, System Identification Theory for the user, Prentice Hall, 1999.

- Astrom K. J., Wittenmark B - "Adaptive Control", Addison Wesley, 1995.
- T. Soderstrom & P. Stoica, “System Identification”, Prentice Hall

Reference Books:

- Eveleigh, V. W. "Adaptive Control and Optimization Techniques", McGraw Hill Book Company, New York, 1967.
- Mendel, J.M. and Fu, K. S. "Adaptive Learning and Pattern Recognition Systems", Academic Press, New York, 1970.
- A. Papoulis, “Probability, Random Variables and sto chastic processes”, 2nd Ed., McGraw Hill, 1983.
- A. Larson and B.O. Schubert, “Stochastic Processes”, Vol. I and II, Holden-Day, 1979. W. Gardener, Stochastic Processes, McGraw Hill, 1986.

503109 : ADVANCED DIGITAL CONTROL TECHNIQUES

Teaching Scheme
Theory: 4 Hrs/Week
Credits:4

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

Unit I: Digital Simulation and 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, solution of the feedback matrix by series expansion, Stability consideration and Constraints on the selection of weighing matrix. (8 Hrs)

Unit II: Design of Discrete Data control Systems by Conventional Methods
Digital P, PI, PID controller, Design of Discrete Data System using Z-Transform method, Simple lag, lead and lag-lead compensators.
(4 Hrs)

Unit III: Pole Placement Design and State Observer
Stability improvement by linear state feedback, Necessary and Sufficient conditions for arbitrary pole placement, 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.
(6Hrs)

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.
(5 Hrs)

Unit VI
Digital Signal Processors - Features, Fixed and Floating point DSP, Selection of DSP. Architecture and Instruction set ofTMS320C54X DSP Processor, instruction pipelining, Application Programs.
(5 Hrs)

Text Books:
- Discrete Time Control Systems, Pearson Education Asia, Katsuhiko Ogata
- Digital Control and State Variable Methods (conventional and Neuro Fuzzy Control), Tata McGraw Hill, M. Gopal
- Digital Signal Processing Implementation using DSP Microprocessors with Examples from TMS 320C54XX, Thomas Publication, Avatar Singh, S. Srinivasan

- Digital Signal Processor, B. Venkatramani, M. Bhaskar, Tata McGraw Hill

Reference Books:

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

503110: (ELECTIVE- II)

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Paper		TW	Oral / Presentation	Total	
503110	Lect/week	In semester Assessment	End Semester Assessment				
	5	50	50	-	-	100	5

Code No.	Modules of 4 credit (Select any one)	Code No.	Modules of 1 credit (Select any one)
503110 M1(i)	Robust Control Systems	503110 M2(i)	Electric Vehicles
503110 M1(ii)	Large Scale Systems	503110 M2(ii)	Fundamentals of Cyber Security
-	-	503110 M2(iii)	Disaster Management
-	-	503110 M2(iv)	Communication protocols in SCADA System
-	-	503110 M2(v)	Mechatronics

503110 M1 (i) : ROBUST CONTROL SYSTEMS

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

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination:50 Marks

Unit I: Introduction
Some common robust control problems. Linear system tools: Jordan and Real Jordan canonical forms, structural decomposition. (4 Hrs)

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. (7 Hrs)

Unit III: Solution to Discrete time Riccati Equations:
Solutions to general DARE and H∞ -DARE. (7 Hrs)

Unit IV: Information in continuous time and discrete time H ∞ optimization:
Full information feedback, output feedback, plants with imaginary axis zeros/unit circle zeros. (6 Hrs)

Unit V: Solutions to continuous time and discrete time H ∞ problems:
Full state feedback, full order output feedback, reduced order output feedback. (6 Hrs)

Unit VI
Robust and perfect tracking of continuous time and discrete time systems, solvability conditions and solutions; solutions to measurement feedback . (6 Hrs)

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

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

503110 M1(ii) : LARGE SCALE SYSTEMS

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

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination:50 Marks

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. (5 Hrs)

Unit II: Parameter estimation for large scale systems
Hierarchical parameter estimation, the multiple projection approach, recursive algorithm for the minimum variance estimator, simulation results. (5 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. (6 Hrs)

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. (6 Hrs)

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. (6 Hrs)

Text Books:

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

Reference Books:

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

503110 M2(i) : ELECTRIC VEHICLES

Teaching Scheme
Lectures: 1 Hr/Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit I

History and development of on-road Electric Vehicles(EV). Different configurations of hybrid EVs with block diagram representation, merits & demerits of different configurations in view of vehicle efficiency 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. Recommended drives 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 M2 (ii) : FUNDAMENTALS OF CYBER SECURITY

Teaching Scheme
Lectures: 1 Hr/Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

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 M2 (iii) : DISASTER MANAGEMENT

Teaching Scheme
Lectures: 1 Hr/Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

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.

References

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 M2 (iv) : COMMUNICATION PROTOCOLS IN SCADA SYSTEM

Teaching Scheme
Lectures: 1 Hr/Week
Credit: 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit I

SCADA Systems: Introduction and definitions of SCADA

Basic SCADA system Architecture: Human Machine Interface, Master Terminal Unit, Remote Terminal Unit Communications for SCADA systems, Configuration of SCADA systems, SCADA system 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, State estimation

(7 Hrs)

Unit II

Communication in power systems: Inductive coordination, Voice communication, carrier systems, 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, IEC61850 layered architecture, Control area network, Control and Information Protocol (CIP), DeviceNet, Control Net, EtherNet/IP, Flexible Function Block process (FFB), Process Field bus (Profibus), The Security Implications of the SCADA protocols.

(7 Hrs)

Text Books:

1. Ronald L. Krutz, “Securing SCADA System”, Wiley Publishing
2. Sunil S. Rao, “Switchgear and Protections”, Khanna Publication
3. Robert Miller, James Malinowski “Power System Operation”, Mc Graw-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 M2 (v) : MECHATRONICS

Teaching Scheme
Lectures: 1 Hr /Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

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 Mc Graw 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 of eight 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 & 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. **System Identification & Adaptive Control:**

   a) Study of Nonparametric methods of system identifications..
   b) Simulation of Self Tuning Regulator
   c) Obtaining the time response of Model Reference Adaptive Control using MATLAB

3. **Advanced Digital Control Technique:**

a) MATLAB based program for digital modeling with sample and Hold device / state variable formulation /Numerical Integration.
b) MATLAB based simulation for study of concept of 'warping & pre-warping' principle.
c) Design an existing control system using digital PID controller
d) Comparison of TMS320C5X & TMS320C54X DSP based program.

503112 : SEMINAR – I

Teaching Scheme
4 Hrs/Week
Credits : 4

Examination Scheme
Term Work : 50 Marks
Oral/ Presentation : 50 Marks

Seminar I **s**hall be on state of the art topic of student's own choice based on relevant specialization approved by an authority. 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.

603101 : ADVANCED DRIVES AND CONTROL

Teaching Scheme	Examination Scheme
Theory: 4 Hrs/Week	In Semester Assessment : 50 Marks
Credits: 4	End Semester Assessment : 50 Marks

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. (7Hrs)

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. (5 Hrs)

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. (6 Hrs)

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. (6 Hrs)

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. (6 Hrs)

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. (6 Hrs)

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 : COMPUTER AIDED CONTROL SYSTEM DESIGN

Teaching Scheme
Theory: 4 Hrs/Week
Credits: 4

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

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. (5 Hrs)

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.
(7 Hrs)

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. (6 Hrs)

Unit IV: Design of nonlinear control systems
Phase plane technique, Describing Function method for nonlinearities like saturation, dead space, ON/OFF nonlinearities. Simulation techniques. (6 Hrs)

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. (6 Hrs)

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.
(6 Hrs)

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. Hadi Saadat, "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: (ELECTIVE III)

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

Code No.	Modules of 4 credit (Select any one)	Code No.	Modules of 1 credit (Select any one)
603103 M1(i)	Intelligent Control	603103 M2(i)	Artificial Intelligent tools
603103 M1(ii)	SCADA Systems and Applications	603103 M2(ii)	Intelligent Sensors and instrumentation
-	-	603103 M3(iii)	Human Rights
-	-	603103 M3(iv)	Green building design
-	-	603103 M3(v)	MEMS and Applications

603103 M1 (i): INTELLIGENT CONTROL

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

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination:50 Marks

Unit I: Introduction to Neural Networks
Introduction, Humans and Computers, Biological Neuron, Biological and Artificial Neuron Models, Historical Developments. Essentials of Artificial Neural Networks: Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN-Connectivity, Neural Dynamics: Activation and Synaptic, Learning Strategy: Supervised, Unsupervised, Reinforcement, Learning Rules.
(6 Hrs)

Unit II: Feed Forward Neural Networks
Introduction, Perceptron Models: Discrete, Continuous and Multi-Category, Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem.
Multilayer feed forward Neural Networks. Credit Assignment Problem, Generalized Delta Rule, Derivation of Back propagation (BP) Training, Summary of Back propagation Algorithm, Learning Difficulties and Improvements.
(6 Hrs)

Unit III: Associative Memories
Paradigms of Associative Memory, Pattern Mathematics, Hebbian Learning, General Concepts of Associative Memory: Associative Matrix, Association Rules, Hamming Distance, The Linear Associator, Matrix Memories, Content Addressable Memory, Bi-directional Associative Memory (BAM) Architecture, BAM Training Algorithms: Storage and Recall Algorithm, BAM Energy Function, Proof of BAM Stability Theorem. Self-Organizing Maps (SOM) and Adaptive Resonance Theory (ART). Introduction, Competitive Learning, Vector Quantization, Self-Organized Learning Networks, Kohonen Networks, Linear Vector Quantization, Stability-Plasticity Dilemma, Feed forward competition, ART1, ART2.
(6 Hrs)

Unit IV: Fuzzy set Theory
Fuzzy versus crisp, Crisp sets: operation, properties, partition and covering, fuzzy sets: membership function, Basic fuzzy set operations, properties of fuzzy sets, crisp relations: Cartesian product, operation and relations, fuzzy relations: Fuzzy Cartesian product, operation on fuzzy relations.
(6Hrs)

Unit V: Fuzzy systems
Crisp logic: 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, defuzzification methods.
(6 Hrs)

Unit VI: Applications based on ANN and Fuzzy Logic Technique
Neural network applications: Pattern recognition, control and Process Monitoring, fault diagnosis and load forecasting. Fuzzy logic application: Greg viot's fuzzy cruise controller, Air conditioner controller. (6 Hrs)

Text Books:

1. Neural Network Design-Hagan, Demuth, Beale- Thomas Learning, Vikas Publishing House
2. Introduction to Artificial Neural Systems - Jacek M. Zuarda, Jaico Publishing House, 1997.
3. 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. Bapi Raju, 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 M1 (ii) : SCADA SYSTEMS AND APPLICATIONS

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

Examination Scheme
In-Semester Examination : 25 Marks
End Semester Examination:50 Marks

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.
(5 Hrs)

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

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

Unit V: Operation and control of interconnected power system
Automatic substation control, SCADA configuration, Energy management system, system operating states, system security, state estimation. (6 Hrs)

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.
(5 Hrs)

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 M2(i) : ARTIFICIAL INTELLIGENT TOOLS

Teaching Scheme
Lectures: 1 Hr /Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

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. Self-organizing fuzzy logic control. Case studies and assignment based on applications of fuzzy logic.

[7Hrs]

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 for solving optimization problems. GA application to power system optimization problem, Case studies: based on use of GA for optimization. [7Hrs]

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 M2(ii) : INTELLIGENT SENSORS AND INSTRUMENTATION

Teaching Scheme
Lectures: 1 Hr/Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit I : Introduction
Sensors: primary sensing principles and measurement variables, sensor performance characteristics and 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; film sensors (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 M2(iii) :HUMAN RIGHTS

Teaching Scheme
Lectures: 1 Hr/Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

Unit 1:
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 2 :
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, Usha Ramanathan
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 M2(iv) : GREEN BUILDING DESIGN

Teaching Scheme
Lectures: 1 Hr/Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

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 parameters and zones, comparative analysis of various climatic zones, site planning recommended check list for identifying site characteristics, site development and layout. Efficient water management and waste 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 of renewable energy system to meet part of building load. Green building certification. Overview various 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 M2 (v) : MEMS AND APPLICATIONS

Teaching Scheme
Lectures: 1 Hr/Week
Credit : 1

Examination Scheme
In-Semester Examination : 25 Marks

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. Nadim Maluf, "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 Mc Graw 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 :4	Oral/ Presentation : 50 Marks

Seminar II shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected by him/her approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

603105 : PROJECT STAGE – I

Teaching Scheme	**Examination Scheme**
8 Hrs/Week	Term Work : 50 Marks
Credits:8	Oral/ Presentation : 50 Marks
	Total : 100 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.) and Layout & Design of the Set-up. As a part of the progress report of Project work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic.

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.

603106 : SEMINAR- III

Teaching Scheme	**Examination Scheme**
5 Hrs/Week	Term Work : 50 Marks
Credits:5	Oral/ Presentation : 50 Marks
	Total : 100 Marks

Seminar III shall preferably be an extension of seminar II**.** 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**
Project: 20 Hrs/Week	Term Work: 150 Marks
Credits:20	Oral Exam.: 50 Marks
	Total : 200 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.

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 and head of the Department/Institute.