Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

Teaching & Examination Scheme of BE (EEP/EE/EEE), effective from July 2014 (Year 2014-15)

Semester-I			Contact hr/week				Examination scheme					
Sr. No.	Subject Code	Subject	L	T	P	Total	CT	TH	TW	PR	Total	Duration of Th. Exam
1	EEP/401	Electric Drives	4		-	4	20	80	-	-	100	3 Hr
2	EEP/402	Power System Protection	4	-	-	4	20	80	-	-	100	3Hr
3	EEP/403	Digital Signal Processing	3	1	-	4	20	80	-	-	100	3Hr
4	EEP/404	Industrial Automation	4	-	-	4	20	80	-	-	100	3Hr
5	EEP/441 EEP/442 EEP/443 EEP/444 EEP/445 EEP/446 EEP/447	**Elective-I** 1. Industrial Management. 2. Artificial Intelligent (Neural Network and Fuzzy Logic) 3. Flexible AC Transmission system. 4. Power Electronics-II. 5. Recent trends in power systems. 6. Digital System Design. 7. Open Elective-I.	4	-	-	4	20	80	-	-	100	3Hr
6	EEP/421	LAB-I:Electric Drives	-	-	2	2	-	-	-	50	50	
7	EEP/422	LAB-II: Power System Protection	-	-	2	2	-	-	-	50	50	
8	EEP/423	LAB-II: Digital Signal Processing	-	-	2	2	-	-	-	50	50	
9	EEP/424	LAB-IV: Industrial Automation	-	-	2	2	-	-	25	-	25	
10	EEP/425	LAB-V: Elective-I	-	-	2	2	-	-	25	-	25	
11	EEP/426	Project Part-I	-	-	-	-	-	-	-	50	50	
		TOTAL	19	1	10	30	100	400	50	200	**750**	

Semester-II			Contact hr/week				Examination scheme					
Sr. No	Subject Code	Subject	L	T	P	Total	CT	TH	TW	PR	Total	Duration of Th. Exam
1	EEP/451	High Voltage Engineering.	4		-	4	20	80	-	-	100	3Hr
2	EEP/452	Power System Operation & Control.	4	-	-	4	20	80	-	-	100	3Hr
3	EEP/453	Renewable Energy.	4	-	-	4	20	80	-	-	100	3Hr
4	EEP/491 EEP/492 EEP/493 EEP/494 EEP/495 EEP/496 EEP/497	**Elective-II** 1. Electrical Power Quality. 2. Electric Traction & Utilization. 3. Electrical System Planning. & Design. 4. Illumination Engineering. 5. Control System-II. 6. Embedded System 7. Open Elective-II.	4	-	-	4	20	80	-	-	100	3Hr
5	EEP/471	LAB-I: High Voltage Engineering.	-	-	2	2	-	-	-	50	50	
6	EEP/472	LAB-II: Power System Operation & Control.	-	-	2	2	-	-	-	50	50	
7	EEP/473	LAB-II: Renewable Energy.	-	-	2	2	-	-	50	-	50	
8	EEP/474	LAB-IV: Elective-II	-	-	2	2	-	-	50	-	50	
10	EEP/475	Project Part -II	-	-	6	6	-	-	50	100	150	
		TOTAL	16	-	14	30	80	320	150	200	**750**	

EEP/401- ELECTRIC DRIVES

Teaching scheme	Examination scheme
Theory: 4Hrs/Week	Theory Paper: 80 Marks
Practical: 2Hrs/Week	Class Test: 20 marks
	Practical& Oral: 50 Marks

Objectives:

- Students will be able to understand the fundamental concepts of electrical drive systems.
- Students will be able to understand the principle of speed control techniques used in various electrical drives.
- Students will be able to select proficiently and the proper electrical drive system for particular application.
- Students will have ability to analyze the performance of electrical drive systems.

UNIT 1: Fundamentals of Electric Drives (10 hours)

Block diagram of an electric drive - parts of electric drives - dynamics of electric drives - torque equations - speed torque conventions - loads with rotational motion - loads with translational motion - components of load torque - load equalization - control of electrical drives - closed loop control - current limit control - speed sensing - current sensing - phase locked loop speed control-procedure to select different drive components such as feedback sensors, power modulator, etc.

UNIT 2: DC Motor Drives (10 hours)

Constant torque and constant power control - single phase controlled rectifiers with motor loads – fully controlled and half controlled rectifier fed dc drives - continuous and discontinuous operation – Four quadrant operation - three phase controlled rectifier fed dc drives - dual converter fed control – chopper fed dc drives - closed loop speed control schemes - braking of dc drives-design procedure for convertor and chopper for DC drives- recent trends in DC drive control-industrial applications of DC drives.

UNIT 3: Three Phase Induction Motor Drives (10 hours)

AC voltage controlled drives - variable frequency control - VSI fed induction motor drive - operation with field weakening - CSI controlled induction motor drives - slip power recovery scheme - rotor resistance control - PWM controlled drives-recent trends in AC drive control-industrial applications of AC drives.

UNIT 4: Synchronous Motor and Brushless DC Motor Drives (10 hours)

Operation from fixed frequency supply- variable frequency control - VSI and CSI fed drives - self-controlled synchronous motor drives employing cyclo-converter - brushless dc motor drives for servo applications- industrial applications of synchronous and BLDC drive.

TEXT/REFERENCE BOOKS:

1) Ned Mohan et al, "Power Electronics: Converters, Applications, and Design", John Wiley & Sons. Inc., 2nd Edition, 1995.
2) G.K. Dubey, "Fundamentals of electric Drives", 2nd Edition, Narosa Publishing Company, 1994/1995.
3) S.K. Pillai, "Electric Drives", University Press India, 1993
4) William and Hulley, "Power Electronic devices and motor control", 2nd Edition, 1995.
5) Werner Leonhard, "Control of electrical drives", Springer, 1995.

LIST OF EXPERIMENTS:

1) Speed control of dc motor using dc chopper.
2) Speed control of dc motor using single- phase converter.
3) Speed control of dc motor using 3- phase converter.
4) Speed control of single- phase induction motor using ac regulator.
5) Inverter fed three-phase induction motor drive.
6) Simulation of Chopper fed DC drive**.**
7) Simulation of DC drive using single phase converter**.**
8) Simulation of three phase IM drive.
9) Simulation of four quadrant DC drive

NOTE: At least 4 experiments have to be performed, remaining 4 experiments from above list have to be studied using simulation tools like PSCAD or MATLAB SIMULINK or any other software tool.

TEACHING–LEARNING MEDIA:

1) Use of audio visual aids in classroom teaching for better understanding the concepts of electrical drives.
2) Use of soft computing techniques to understand the fundamentals of electrical drives.
3) Inviting subject experts to make aware of latest drive technologies to students.
4) Arranging industrial visits.

EEP/402- POWER SYSTEM PROTECTION

Teaching Scheme
Theory: 4 Hrs/Week
Particles: 2 Hrs/Week

Examination Scheme
Paper: 80 Marks
Class Test: 20 Marks
Practical & Oral: 50 Marks

UNIT 1: Introduction to Protective Relaying (04 hours)

Requirement of protective relaying, zones of protection, terminologies involved in relaying, desirable qualities of protective relaying, classification of protective schemes, current transformer and potential transformer, summation transformers.

UNIT 2: Relays (08 hours)

Classification of relays, construction, working principle, characteristics and application of electromagnetic relay, relay setting, different types of relays- static relay, induction type earth fault relay, directional relay, distance relay, differential relay, Translay relay, negative sequence relay & electro-thermal relay, introduction to static relay.

UNIT 3: Protection Schemes (08 hours)

Alternator Protection: Stator and rotor faults, unbalanced loading, overloading, prime mover failure, overvoltage, restricted earth fault protection, Merz- price earth fault protection.

Transformer Protection: Harmonic restraint, over current & unrestricted earth fault, restricted earth fault, frame leakage protection Buchholz relay, Merz-price protection,

Induction Motor Protection: Protective circuits for single phasing preventor, phase fault, ground fault, phase reversal protection.

UNIT 4: Protection of Transmission Lines (06 hours)

Protection schemes for feeder, Busbar & transmission lines using Differential, Distance (Impedance) protection and Carrier current protection.

Protection against lighting: Protection of power station & substation against direct strokes, protection of transmission lines against direct strokes, protection against traveling waves, rod gap lightning arresters, L.A. ratings, locations & effect of cables, surge absorber, Peterson coil.

UNIT 5: Circuit Breakers (10 hours)

Arc phenomenon- Arc formation, Arc interruption, Different arc interruption theories, current zero interruption, recovery voltage, Restriking voltage, Arc voltage, Active recovery voltage in a 3 phase circuit, Rate of Rise of Restriking Voltage (RRRV), Resistive switching, current chopping, interruption of capacitive current.

Classification of circuit breakers: Construction & working principle of air break, air blast, Minimum oil, SF6, Vaccum circuit breakers, MCB, ELCB, Rating & selection of circuit breakers, standard rating & applications of circuit breakers.

UNIT 6: Microprocessor Based Protective Relays (04 hours)

Introduction, over current relays, Impedance relay, Directional relay, Reactance relay.

TEXT BOOKS:

1) Switchgear & protection by Sunil S. Rao.
2) Power system engineering by A.C. Chakrabarti, Soni-Gupta-Bhatnagar.
3) Power system protection & switchgear by Badriram, D.N. Vishwakarma.
4) Fundamentals of power system protection by V.G. Paithankar & S.R. Bhide.

REFERENCE BOOKS:

1) Switchgear & protection by Ravindranath & M. Chander.
2) The art & science of protective relaying by C.R. Mason.

TERM WORK:

Term work shall consist of record of minimum eight experiments from the following:

1) Study & use of relay testing kit.
2) Characteristics of over current relay.
3) MCB, ELCB testing & characteristics.
4) Differential protection of transformer.
5) Differential protection of alternator.
6) Restricted earth fault protection of alternator.
7) Negative sequence protection of alternator.
8) Ground fault protection of induction motor.
9) Single phase preventer of induction motor.
10) Three phase induction motor protection.
11) Distance protection of transmission line.
12) Study of air circuit breaker.
13) Study & application of directional relay.
14) Study & application of definite time under/over voltage relay.

EEP/403- DIGITAL SIGNAL PROCESSING

Teaching Scheme:
Theory: 4hrs /Week
Practical: 2Hrs /Week

Examination Scheme:
Theory Paper: 80marks,
Class Test: 20Marks
Practical & Oral: 50 Marks

UNIT 1: Introduction to Digital Signal Processing (8 hours)

Signals, Systems and Signal Processing: Basic Elements of a Digital Signal Processing System, Advantages of Digital over Analog Signal Processing.

Classification of Signals: Multichannel and Multidimensional Signals, Continuous-Time versus Discrete-Time Signals, Continuous-Valued Versus Discrete-Valued Signals, Deterministic Versus Random Signals.

The Concept of Frequency in Continuous-Time and Discrete-Time Signals: Continuous-Time Sinusoidal Signals, Discrete-Time Sinusoidal Signals, Harmonically Related Complex Exponentials.

Analog-to-Digital and Digital-to-Analog Conversion: Sampling of Analog Signals, the Sampling Theorem, Quantization of Continuous-Amplitude Signals, Quantization of Sinusoidal Signals, Coding of Quantized Samples, Digital-to-Analog Conversion, Analysis of Digital Signals and Systems versus Discrete-Time Signals and Systems.

UNIT 2: Discrete-Time Signals and Systems (8 hours)

Discrete-Time Signals: Some Elementary Discrete-Time Signals, Classification of Discrete-Time Signals, Simple Manipulations of Discrete-Time Signals.

Discrete-Time Systems: Input-Output Description of Systems, Block Diagram Representation of Discrete-Time Systems, Classification of Discrete-Time Systems, Interconnection of Discrete-Time Systems.

Analysis of Discrete-Time Linear Time-Invariant Systems: Techniques for the Analysis of Linear Systems, Resolution of a Discrete-Time Signal into Impulses, Response of LTI Systems to Arbitrary Inputs: The Convolution Sum, Properties of Convolution and the Interconnection of LTI Systems, Causal Linear Time-Invariant Systems, Stability of Linear Time-Invariant Systems, Systems with Finite-Duration and infinite-Duration Impulse Response.

Discrete-Time Systems Described by Difference Equations: Recursive and Nonrecursive Discrete-Time Systems, Linear Time-Invariant Systems Characterized by Constant-Coefficient Difference Equations, Solution of Linear Constant-Coefficient Difference Equations, The Impulse Response of a Linear Time-Invariant Recursive System

UNIT 3: Z-Transform and its Application to the Analysis of LTI systems (6 hours)

Z-Transform: Direct z-Transform, Inverse z-Transform.

Properties of z-transform.

Rational z-Transforms: Poles and Zeros. Pole Location and Time-Domain Behavior for Causal Signals, System Function of a Linear Time-Invariant System.

Inversion of the z-Transform: Inverse z-Transform by Contour Integration, Inverse z-Transform by Power Series Expansion, Inverse z-Transform by Partial-Fraction Expansion, Decomposition of Rational z-Transforms,

One-sided z-Transform: Definition and Properties, Solution of Difference Equations.

UNIT 4: Frequency Analysis of Signals and Systems (4 hours)

Properties of the Fourier Transform for Discrete-Time Signals: Symmetry Properties of the Fourier Transform, Fourier Transform Theorems and Properties.

UNIT 5: Discrete Fourier Transform: Properties and Applications (8 hours)

Frequency Domain Sampling: The Discrete Fourier Transform: Frequency-Domain Sampling and Reconstruction of Discrete-Time Signals, Discrete Fourier Transform (DFT), DFT as a Linear Transformation, Relationship of the DFT to Other Transforms.

Properties of the DlT: Periodicity. Linearity and Symmetry Properties, Multiplication of Two DFTs and Circular Convolution, Additional DFT Properties.

UNIT 6: Implementation of Discrete- Time Systems (6 hours)

Structures for the Realization of Discrete-Time Systems.

Structures for FIR Systems: Direct-Form Structure, Cascade-Form Structures, Frequency-Sampling Structures, Lattice Structure.

Structures for IIR Systems: Direct-Form Structures, Signal Flow Graphs and Transposed Structures, Cascade-Form Structures, Parallel-Form Structures, Latticc and Lattice-Ladder Structures for IIR Systems.

REFERENCE BOOK:

1) John G. Proakis, Dimitris G.Manolakis, “Digital Signal Processing”.
2) Shalivahanan, Vallavaraj and Gnanapriya, “Digital Signal Processing”

TEXT BOOK:

1) N.G.Palan, “Digital Signal Processing”
2) Ramesh Babu, “Digital Signal Processing”
3) Alon V. Oppenhelm, “Digitsl Signal Processing”, PHI Pub.
4) S.K.Mitra, “Digital Signal Processing”, TMH Pub.

TERM WORK:

List of Experiments: Perform the experiments using MATLAB/Scilab/Octave:

1) To represent basic signals (Unit Step, Unit Impulse, Ramp, Exponential, Sine and Cosine).
2) To develop the program for discrete convolution
3) To develop the program for discrete correlation.
4) To verify stability test.
5) To verify sampling theorem.
6) To design FIR Filter using window technique..
7) To design Digital IIR filter.
8) To design a program to compare direct realization values of digital IIR filter.
9) To design a program for computing parallel realization values of IIR filter.
10) To design a program for computing cascade realization values of IIR filter.
11) To design a program for computing inverse z transforms.

Note: At least eight experiments have to be performed in the semester.

EEP/404- INDUSTRIAL AUTOMATION

Teaching Scheme:
Theory: 4hrs /Week
Practical: 2Hrs /Week

Examination Scheme:
Theory Paper: 80marks,
Class Test: 20Marks
Term Work: 25 Marks

UNIT 1: Introduction [07 hours]

Introduction, Definition of Automation, Mechanical (levers, linkages, Gearboxes) /Hydraulic/Pneumatic/Electrical/Electronic/Computerized), Concepts of Hierarchy of Automation: i)Operation Automation [to Automate only one operation], ii) Machine Automation, Machine & Equipment Automation: Sequential Logic Control. iii) Process Automation, Process automation needs: Continuous event based action control. iv) Factory Automation, v) System Automation vi) Industrial Automation System.

UNIT 2: Levels of Automation [06 hours]

Levels of automation: Manually operated/Semi-automatic/Fully Automatic.
Techno-commercial requirement & feasibility decides level of automation. i) Discrete process control. ii) Batch process control iii) Continuous process control. Technologies used for Automation a) Traditional control system, its features, merits and de-merits, b) Distributed control system, its features, merits and de-merits, c) System of Supervisory control and data acquisition, its features, merits and de-merits.

UNIT 3: Programmable Logic Controllers (PLCs) and Advanced PLC Functions [06 hours]

Review of PLC: Ladder diagram, Programming, Communication standard (RS232, RS485), Modbus (ASCII/RTU), Analog PLC operation, PLC interface.

Motors Controls: AC Motor starter, AC motor overload protection, DC motor controller, Variable speed (Variable Frequency) AC motor Drive.

UNIT 4: SCADA [08 hours]

Basic SCADA system Architecture: Human Machine Interface, Master Terminal Unit, Remote Terminal Unit. Alarm Handling and Trending, Access Control, Automation Logging, Archiving, Report Generation.

Interfaces to H/W and S/W Types of interfaces**:** i) Command-line interfaces, ii) Graphical user interfaces, iii) Web-based user interfaces.
Operational interfaces: i) Batch interface ii) Gesture interfaces iii) Reflexive user interfaces. iv)Tactile interfaces v) Tangible User Interface. vi)Text user interfaces. vii) Touch interface.

SCADA Communication, standard communication protocols.

UNIT 5: SCADA Hardware: refer lecture 2: SCADA hardware [06 hours]

SCADA Hardware: Hardware Architecture, Properties and Functions of Software, Configuration of SCADA system.

SCADA Applications(REFER LECTURE 11: Operation and control of interconnected power system, Automatic substation control, Conventional Electric Power Generation, Transmission and Distribution sector operation.

UNIT 6: Distributed Control System [07 hours]

Introduction and overview, history, system architecture, system elements, communication links, difference between centralized and distributed control system. Displays: group display, overview display, detail display, local control units, mean time between failures, data Highways, field buses, multiplexers and remote sensing terminal units, I/O hardware, study of any one DCS.

TEXT BOOK:

1) "Process Control", Peter Harriot, Tata McGraw-Hill.
2) "Process System analysis and Control", Donald R. Coughnour, McGraw-Hill, 1991.
3) "Process dynamics and control", D E Seborg, T. F. Edger, John Wiley, 1989.
4) "Programmable Logic Devices and logic Controllers", Enrique Mandado, Jorge Marcos and Serafin A Perrez, Prentice-Hall, 1996.
5) "Distributed Computer Control for Industrial Automation", Dobrivoje Popovic, Vijay P Bhatkar, Marcel Dekker INC, 1990.
6) Hughes: Programmable Controllers, ISA Publications, 1989.
7) Stuart A Boyer: SCADA supervisory control and data acquisition.
8) Gordan Clarke, Deon Reynders, Practical Modern SCADA Protocols.
9) M. Lucas: Distributed Control Systems.
10) Understanding Distributed Process Systems for Control, Samuel Herb, ISA.

REFERENCE BOOKS:

1) B. G. Liptak, Instrument Engineer's Handbook, Process Control, Third Edition, Chilton Book company, 1996.
2) C. D. Johnson, Process Control Instrumentation technology, Prentice- Hall of India, 1993.
3) Sunil S. Rao, Switchgear and Protections, Khanna Publication.

TERM WORK:

Minimum EIGHT experiments out of following:

1) PLC supply, input, output wiring scheme development & testing.
2) Study of digital inputs, outputs, Analog Inputs, outputs.
3) Pump Control for Overhead Water Tank Level maintenance.
4) Timer function application Study.
5) Counter function application, for

1) Standard Digital Input.
2) High Speed Inputs (Encoders, digital scales) – Study.

6) Speed Measurement of Motor.
7) Speed Control of Induction Motor from SCADA, PLC through VFD.
8) DOL starter & star delta starter operation by using PLC.
9) Measurement of voltage, current, PF, Power & Energy.
10) Study of Ladder Diagram logic programming.
11) Study of function blocks & their applications in logic programming.
12) Stepper motor control through PLC for motion control (High speed pulse train output)
13) Temperature measurement using analog input.
14) Alarm annunciation using SCADA.
15) Reporting & trending in SCADA system.
16) Case study of Industrial DCS.
17) Interface of DCS with SCADA/PLC using protocol/fieldbus.

EEP/441- Elective-I: INDUSTRIAL MANAGEMENT

Teaching Scheme
Theory: 4 Hrs/Week
Particles: 2 Hrs/Week

Examination Scheme
Paper: 80 Marks
Class Test: 20 Marks
Term-work: 25 Marks

UNIT 1: (08 hours)

Industrial Management: Principles and Importance of management, Functions of management, Decision making process.

Operations Management: Production concept, production planning and control, manufacturing systems: types and characteristics, plant layout types, need and characteristic, salary and wage administration.

UNIT 2: (08 hours)

Human Resource Management: Concept, Objective and Functions of HRM, Principles of good HR policy, Incentives: types and characteristics.

Financial Management: Types of Capital, Source of finance, Institutions building Industrial finance, Taxation policies, Taxes: direct and indirect.

UNIT 3: (08 hours)

Marketing Management: Functions of Marketing, Market research, Sales Management, Sales organization and its functions, sales forecasting, the selling and marketing concept.

Network Analysis: Network Techniques, Terms related to Network Planning, PERT, CPM, Applications of Network Technique.

UNIT 4: (08 hours)

Material Management: Introduction to Material Management, Purchasing, Buying Technique, Purchasing procedure, Inventory control, Inventory Management, Material requirement planning.

Total Quality Management: Definition, Quality obstacles, Benefits of TQM,ISO registration benefits, ISO 9000 series standards, sector specific standards, ISO 9001requirements, Introduction to ISO 14000 series, Testing standards

UNIT 5: (08 hours)

Industrial Acts: Indian factory act, Indian Electricity act, The Workmen's compensation act, Consumer Protection act.

Engineering Economics: Meaning of economics, difference between value and price, law of demand and supply, demand forecasting methods, Banks: functions and types, RBI, SEBI, modern concepts like SEZ, PPP, BOT.

UNIT 6: (08 hours)

Management Information Systems: Introduction, Elements, Structure and Requirements of MIS, Decision support system.

Operations Research: LPP (Graphical only), Transportation Problem, Assignment Problem, Inventory Model (EOQ, Stock levels).

REFERENCE BOOKS:

1) Industrial Engineering and Management: O.P. Khanna; Dhanpatrai and Company
2) Management Information Systems by G.B. Davis, M.H. Olson: McGrawhill; International Edition.
3) Total Quality Management by D.H. Besterfield, C.B. Michana& others; PHI Pvt. Ltd.
4) ISO 900 quality systems: A. N. Singh; Dolphin Book N Delhi.
5) Business organization and management: M.C. Shukla; S. Chand.
6) Operations Research by S. D. Sharma.

EEP/442- Elective-I: NEURAL NETWORKS & FUZZY LOGIC

Teaching Scheme
Theory: 4 Hrs/Week
Particles: 2 Hrs/Week

Examination Scheme
Paper: 80 Marks
Class Test: 20 Marks
Term-Work: 25 Marks

UNIT 1: Neural Networks [08 hours]

Biological Neuron and Their Artificial Model; Models of Artificial Neural Network: Single Layer and Multilayer, Feed-forward Network, Feedback Network; Neural Processing; Types of Neuron Activation Function; Learning Strategy: Supervised, Unsupervised, Reinforcement; Learning Rules; Auto-Associative and Hetro-Associative Memory.

UNIT 2: Back Propagation Networks [09 hours]

Architecture: Perceptron model, Single-Layer Perceptron Network, Multilayer Perception Model; Back Propagation Learning Methods; Generalized Delta Learning Rule; Back Propagation Algorithm; Factors Affecting Back-Propagation Training; Learning Factors: Initial Weights, Steepness of the Activation Function, Learning Constant, Momentum Factor, Necessary Number of Hidden Neurons.

UNIT 3: Introduction to Fuzzy Logic [08 hours]

Classical Sets and Fuzzy Sets: Operations and Properties; Classical relations and fuzzy relations: Cartesian product, Crisp relations, Fuzzy relations, Operations on fuzzy relations, Properties of Fuzzy Relations, Fuzzy Cartesian Product and Composition; Tolerance and Equivalence Relations; Fuzzy Tolerance and Equivalence Relations; Value Assignments.

UNIT 4: Fuzzy Logic System [09 hours]

Membership Function: Various Forms, Membership Value Assignments; Fuzzification and Defuzzification Module, Rule Base, Choice of Variable and Contents of Rules, Derivation of Rules, Data Base, Fuzzy Inference System, Choice of Membership Function and Scaling Factors, Choice of Fuzzification and Defuzzification Procedure, Various Methods; Fuzzy Associative Memories.

UNIT 5: Neural Network and Fuzzy Logic Control Applications [06 hours]

Applications of Fuzzy Logic: PID Control, Speed control of DC/AC motors, Power Plants, Image Processing, Inverted pendulum, Temperature control, Hybrid Neuro-Fuzzy Applications.

TEXT/REFERENCE BOOKS:

1) B. Yegnanarayana, “Artificial neural networks”, Prentice Hall of India, Private limited, New Delhi.
2) J. M. Zurada, “Introduction to Artificial Systems”, Singapore: Info Access and distributions/ West Publishing Company.
3) James A. Anderson, “An Introduction to Neural Networks”, Practice Hall India Publication.

4) D. Drainkov, H. Hellendoorn and M. Reinfrank, “An Introduction to Fuzzy Control”, Narosa Publishing House.
5) Siman Haykin, “Neural Networks”, Prentice Hall of India.
6) T. J. Ross, “Fuzzy Logic with Engineering Applications”, John Wiley & Sons.
7) S. Rajsekaran & G.A. Vijayalakshmi Pai, “Neural network, Fuzzy logic and Genetic Algorithm”, Prentice Hall of India.
8) S. N. Sivanandam, S. Sumathi, S. N. Deepa, “Introduction to Neural Network Using MATLAB 6.0”, Tata McGraw Hill.

TERM WORK:

Term work shall consist of record of minimum eight experiments from the following:

1) Logical operation using Neural Network.
2) Different types of Learning methods in Neural Network.
3) Feed-Forward and Feedback Neural Network.
4) Single layer Perceptron Feed-Forward Neural Network.
5) Multi layer Perceptron Feed forward Neural Network.
6) Back Propagation Neural Network.
7) Arithmetic operation on Fuzzy Sets.
8) Generation of different Activation function.
9) Fuzzification and Defuzzification methods.
10) Fuzzy Logic Controller Application.
11) Neural Network Application.
12) Neuro-Fuzzy Applications.

EEP/443- Elective-I: FLEXIBLE AC TRANSMISSION SYSTEM

Teaching Scheme
Theory: 4 Hrs/Week
Particles: 2 Hrs/Week

Examination Scheme
Paper: 80 Marks
Class Test: 20 Marks
Term-Work: 25 Marks

UNIT 1: Flexible AC Transmission Systems (FACTS) Concept and general System Considerations (04 hours)

Introduction, Transmission inter connections, Power flow in parallel paths, Power flow in Meshed System. What limits the loading capacity, Relative Importance of Controllable parameters.

UNIT 2: FACTS controllers and Converters (06 hours)

Introduction, Basic types, relative importance of different types of controllers, Shunt connected controllers, Series connected controllers, combined series and parallel controllers, other controllers. Basic concepts of voltage source FACTS converters, single phase and three phase full wave bridge FACT converter operations.

UNIT 3: Static Shunt Compensator (10 hours)

Static Shunt Compensator: Static VAR Compensator (SVC) and Static Synchronous Compensator (STATCOM)

Introduction, Objectives of shunt compensation, Methods of controllable VAR generation, Static VAR compensators SVC and STATCOM ,Comparison between SVC and STATCOM, Static VAR systems.

UNIT4: Static Series Compensator (08 hours)

Static series Compensators: GTO Thyristor-Control Series Capacitor (GCSC), Thyristor Switched Series Capacitor (TSSC), Thyristor Control Series Capacitor (TCSC) and Static Synchronous Series Compensator (SSSC).

Introduction, Objectives of series compensation, Variable impedance type Series compensators, switching converter type series compensators.

UNIT 5: Static Voltage and Phase Angle Regulators (08 hours)

Static voltage and phase angle Regulators: Thyristor Control Voltage Regulator (TCVR) and Thyristor Control Phase Angle Regulator (TCPAR)

Introduction, Objectives of voltage and phase angle Regulation, approaches to Thyristor Controlled Voltage and phase angle Regulators. Switching converter based voltage and phase angle regulators, hybrid phase angle regulators.

UNIT 6: Combined Compensators (04 hours)

Combined Compensators: Unified Power Flow Controller (UPFC) , Interline Power Flow Controller (IPFC) and Special purpose facts controllers.
Concepts of UPFC, IPFC, N.G. Hingorani-sub synchronous resonance (NGH-SSR) damping scheme and Thyristor controlled Braking Resistor and application of FACTS.

TEXT BOOKS:

1. "Understanding FACTS Devices" N.G. Hingorani and L. Guygi, IEEE Press Publications 2000.

TERM WORK:

The Term-work consists of minimum EIGHT experiments from following list.

1) Simulation of Static VAR Compensator (SVC).
2) Simulation of Static synchronous compensator (SSC).
3) Simulation of GTO Thyristor control series capacitor (GCSC).
4) Simulation of Thyristor switched series capacitor (TSSC).
5) Simulation of Static Synchronous Series Compensator (SSSC).
6) Study of Thyristor Control Voltage Regulator (TCVR).
7) Study of Thyristor Control Phase Angle Regulator (TCPAR).
8) Study of Unified Power Flow Controller (UPFC).
9) Study of Interline Power Flow Controller (IPFC).
10) Study of Thyristor Control Series Capacitor (TCSC).
11) Study single phase and three phase full wave bridge FACT converter.

Industrial Visit: Industrial visit to High Voltage Transmission Substation.

EEP/444- Elective-I: POWER ELECTRONICS - II

Teaching Scheme
Theory: 4 Hrs/Week
Particles: 2 Hrs/Week

Examination Scheme
Paper: 80 Marks
Class Test: 20 Marks
Term Work: 25 Marks

UNIT 1: Basic Concepts of Power Semiconductor Devices (02 hours)

Power Diode, SCR, GTO, Power MOSFET, IGBT and IGCT.

UNIT 2: AC-DC Power Converters (08 hours)

Review of Single and Three-Phase Controlled Rectifier, Power Factor Improvement: Extinction Angle Control, Symmetric Angle Control, PWM Control, Single-Phase Sinusoidal PWM, Three-Phase PWM Rectifier. Concept of Twelve-Pulse Converters.

UNIT 3: DC-AC Power Converters (08 hours)

Review of Single-phase and Three-phase Inverters, Voltage Control of Single Phase Inverters, Advanced Modulation Techniques, and Voltage Control of Three-Phase Inverters.

UNIT 4: Multilevel Inverters (08 hours)

Diode Clamped Multilevel Inverter, Flying Capacitor Multilevel Inverter, Cascaded Multilevel Inverter, Applications of Multilevel Inverter, Comparison of Multilevel Inverters.

UNIT 5: Resonant Pulse Inverters (08 hours)

Series Resonant Inverter, Frequency Response of Series Resonant Inverter, Parallel Resonant Inverters, Voltage Control of Resonant Inverters, Class E Resonant Inverter, ZCS Resonant Converters, ZVS Resonant Converters, Comparison between ZCS and ZVS Resonant Converters.

UNIT 6: DC Power Supplies (06 hours)

Fly-back Converter, Forward Converter, Push-Pull Converter, Half Bridge Converter, Full Bridge Converter, Control Circuits.

REFERENCE BOOK:

1) Power Electronics: Circuits, Devices and Applications by Muhammad Rashid, Third Edition, Pearson Education, Inc.
2) Power Electronics: Converters, Applications and Design by Ned Mohan, Third Edition, Wiley India Publishers.
3) Power electronics M. D. Singh, K.B. Khanchandani, 2nd Edition TMH.

TERMWORK:

Term-work shall consist of minimum EIGHT experiments from following list.

1) Single Phase Controlled Rectifier.
2) Three-Phase Thyristor Controlled Converter.

3) Three-Phase Two-Level PWM Converters.
4) AC/DC Three Level PWM Converters.
5) Three-Phase Three Level PWM Converters.
6) Two-Level PWM Converter and effect of dead-time.
7) Three-Level PWM Converter and effect of dead-time.
8) AC-DC-AC PWM Converters.
9) Fly-back Converter.
10) Forward Converter.

EEP/445- Elective-I: RECENT TRENDS IN POWER SYSTEM

Teaching Scheme
Theory: 4 Hrs/Week
Particles: 2 Hrs/Week

Examination Scheme
Paper: 80 Marks
Class Test: 20 Marks
Term-Work: 25 Marks

Course objectives:

- To provide students with in-depth understanding of smart grid technology and systems.
- To provide students with the principles, devices used to harness solar energy.
- To provide students with in-depth understanding of recent technologies in Photo voltaic.
- To provide students with in-depth understanding of energy storage systems required in power system.

UNIT 1: Introduction to Smart Grid (08 hours)

Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid, Case study of Smart Grid, CDM opportunities in Smart Grid.

UNIT 2: Smart Grid Technologies: Part 1 (06 hours)

Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers

UNIT 3: Smart Grid Technologies: Part 2 (06 hours)

Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).

UNIT 4: Microgrids and Distributed Energy Resources (06 hours)

Concept of microgrid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, thin film solar cells, Variable speed wind generators, fuel cells, micro-turbines, Captive power plants, Integration of renewable energy sources.

UNIT 5: Technologies in Solar Photo Voltaic (08 hours)

Basic Semiconductor Physics, a Generic Photovoltaic Cell, the Simplest Equivalent Circuit for a Photovoltaic Cell from Cells to Modules to Arrays Crystalline Silicon Technologies, Single-Crystal Czochralski (CZ) Silicon, Ribbon Silicon Technologies, Cast Multicrystalline Silicon, Crystalline Silicon Modules, and Thin-Film Photovoltaic.

Photo voltaic (PV) technology: Present status, solar cells , cell technologies, characteristics of PV systems, equivalent circuit, array design , building integrated PV system, its components , sizing and economics. Peak power operation, Standalone and grid interactive system

UNIT 6: Energy Storage Systems (06 hours)

Flywheel energy storage system, superconducting magnetic energy storage system, other energy storage systems, active filters, shunt, series and hybrid filters

TEXT BOOKS:

1) Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press.
2) Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley.
3) Jean Claude Sabonnadière, Nouredine Hadjsaïd, "Smart Grids", Wiley Blackwell.
4) Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010.
5) Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press.
6) S.P. Sukhatme "Solar Energy', Tata McGraw Hill.
7) Chetan Singh Solanki, "Renewable Energy Technologies: A Practical Guide for Beginners", PHI Publication**.**
8) Gilbert M. Masters, "Renewable and Efficient Electrical Power Systems", Wiley - IEEE Press, August 2004.
9) E. Acha, Miller & Others, "Power Electronic Control in Electrical Systems ", Newness, Oxford publication.
10) S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009

REFERENCE BOOKS:

1) Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011.
2) Yang Xiao, "Communication and Networking in Smart Grids", CRC Press**.**
3) G. N. Tiwari, Swapnil Dubey , "Fundamentals of Photovoltaic Modules and Their Applications", RSC publishing series**.**
4) Solar Electricity Handbook, Michael Boxwell, Greenstream Publishing, 2013

TERM WORK:

Term work shall consist of case studies based on following topics:

1) Smart Grid implementation.
2) Grid connected solar photo voltaic**.**
3) Micro-grid implementation**.**
4) Distributed Generation.
5) Energy storage system.

EEP/446- Elective-I: DIGITAL SYSTEM DESIGN

Teaching Scheme
Theory: 4 Hrs/Week
Particles: 2 Hrs/Week

Examination Scheme
Paper: 80 Marks
Class Test: 20 Marks
Term Work: 25 Marks

UNIT 1: MOS Devices (06 hours)

Introduction to MOST,I-V characteristics of NMOS and PMOS, second order effects-CLM, Body bias, short channel effects-VT roll off, DIBL, Mobility degradation, Transfer characteristics of CMOS inverter, Detailed analysis of CMOS inverter with parasitic.

UNIT 2: CMOS Design (08 hours)

CMOS logic families-static, dynamic including their timing analysis and power consumption, CPL, Pass transistor logic, Transmission gate, circuits using CPL and pass transistor logic.

UNIT 3: Fabrication and Layout (06 hours)

Basic CMOS technology, self aligned CMOS process, N well, P well, Twin tub, Layout of CMOS inverter, Design rules, Verification of layout

UNIT 4: Introduction to VHDL (06 hours)

Introduction, EDA Tool-VHDL, Design flow, Introduction to VHDL, Elements of VHDL, Modelling styles-sequential, structural, and data flow modeling , sequential and concurrent statements

UNIT 5: Circuit Design Using FPGA &CPLD (06 hours)

Function, Procedures, Attributes, Test benches, synthesizable and no synthesizable statements, packages and configurations. The state diagram, modeling in VHDL with examples such as counters, registers and bidirectional bus. Introduction, study of architecture of CPLDs and FPGAs

UNIT 6: Testability (08 hours)

Need of design for testability, introduction to fault coverage, Testability, Design for testability, controllability, absorbability, stuck at fault model, stuck open and stuck short faults, Boundary scan check, JTAG technology, TAP controller, and TAP controller state diagram, scan path, Full and partial scan.

TEXT BOOKS:

1) N. Weste and K. Eshranghian, Principles of CMOS VLSI Design, Addison Wesley.
2) J. Rabaey, Digital Integrated Circuits: A Design perspective, PHI
3) D. Perry, VHDL, 2nd edition, TMH, 1995.
4) Kang S.M, CMOS Digital Integrated Circuits, TMH 3rd 2003.

5) Bushnell Agrawal, Essentials of Electronic Testing for Digital memory and mixed signal VLSI circuits, Kulwar academic publisher.

REFERENCE BOOKS:

1) Boyee and Baker, CMOS, EEE Press.
2) Xilinx FPGA/CPLD data book.
3) VHDL Primer, Addison Weslay Longman,2000, J Bhaskar.

TERMWORK:

Term-work shall consist of minimum EIGHT experiments from above UNITS.

EEP/447- Elective-I: OPEN ELECTIVE-I

Teaching Scheme	Examination Scheme
Theory: 4 Hrs/Week	Paper: 80 Marks
Particles: 2 Hrs/Week	Class Test: 20 Marks
	Term Work: 25 Marks

Open Elective is a powerful tool introduced in the final year of Engineering syllabus which allows a student to design the syllabus of a subject of his own choice and then introduce the subject as an Elective Subject into the curriculum so that students can then option for this subject as an Elective subject, but this subject were not initially available into the main stream curriculum, after approving it from the University.

Open elective can be of great value to all students if properly utilized. Suppose from all the given options for Electives, student don't find any subject of good use to them or if all the given subjects are of hardly any interest to them then they can introduce a subject of their choice with students own syllabus for Elective. Students are allowed to study a subject of their choice.

- If student have finally decided to option for Open Elective and student would now like to design the syllabus for the subject, and then the syllabus should be designed with the help of any senior faculty of your department (preferably HOD) and along with the help of any representative from the industry.
- After student have designed the syllabus of the subject student are interested, student need to first get it approved from the senior most Faculty member of department (preferably HOD). Once the HOD approves the syllabus, the syllabus is then forwarded to the University for scrutinizing the contents. The level of the subject should definitely be suitable for BE and should also be a useful subject for the student from an Engineering Degree's point of view. Once approved by the University, the college who had requested the approval is notified about the approval of the subject, so that the students can then option for the subject as their Elective subject. Also, after a small period of time, the syllabus of the subject is then assigned a valid subject number and is then officially displayed on University's official website.
- There should always be a handsome number of students for conducting an exam for a particular subject. This number should be above a desired threshold level for the subject to be approved. Normally the number is preferred as minimum of 25 students, but generally the threshold number of students is decided internally by the department and the University.
- This entirely depends on the quality and level of the syllabus and the subject you have designed. If the scrutinizing officials feel that the subject is much below or beyond the scope of BE, then the chances of being Rejected is more else the deal is definitely approved.
- An ideal date for submitting the syllabus to the University would be before the Nov/Dec Semester Examination commences (i.e. Before 1st Semester Exams).

- Once approved, the syllabus is officially displayed on the University's website and is also communicated to most colleges. The students are then allowed to option for the Open Elective Subject if the criteria of number of students are met by the department's needs.

EEP/426- PROJECT PART- I

Teaching Scheme:
Practical: 2Hrs/week

Exam Scheme:
Practical & Oral: 50 Marks

The Project Seminar will consist of a type written report covering the topic selected for project report. This should include the Literature Survey, Technical details and related data required for the project.

The candidate shall deliver a project seminar on the subject chosen in the presence of Internal and External examiner appointed by the University.

The assessment is based on Innovative Idea, Depth of Understanding, Applications, Individual contributions, and Presentation, and the grade given by the examiner, which is based on the work carried out in a semester.

NOTE: There is provision of Multidisciplinary Project.

MULTIDISCIPLINARY PROJECT: The multidisciplinary project (MDP) aims to teach students by means of real problems to combine and apply their knowledge and skills and to integrate these in non-technical aspects of importance and new technical knowledge. The main objects in this project are to learn to communicate with colleagues with other disciplines, and to gain experience in working as a team in the thematic execution of projects.

The multidisciplinary project is set up according to the model of project. The characteristic feature of the project is that students work in groups of max 6 students, under supervision of a guide, at least one from each discipline involved in project. The MDP teaches students to work problem-solving in teams. As such, the MDP forms an excellent preparation to the work awaiting the future engineers in pursuance of their profession. The problems that will be worked on can be very divergent in nature.

Assignments can be put forward by all interested professors of respective departments. The nature of the problems that will be worked on will be such that the problems can only be solved by a combination of knowledge from various departments. Working in a team, a group of students will have to complete the project in stipulated time. Communication with people, meeting techniques, presentation and reporting are also important parts in the entire process.

The goals of this program are:

1) To develop an understanding of engineering design projects from recognition of a need and definition of objectives through completion of the project,
2) To foster student creativity and enhance the student's communication skills.
3) To broaden the student's concept of engineering problems to include all engineering disciplines and other non-engineering factors that have an impact on the final problem solution.

4) To provide a unique educational experience for students on project teams and

Evaluation MDP Project will be done by the guide of respective discipline, as per given in teaching scheme.

EEP/451- HIGH VOLTAGE ENGINEERING

Teaching Scheme
Theory: 4 Hrs/Week
Particles: 2 Hrs/Week

Examination Scheme
Paper: 80 Marks
Class Test: 20 Marks
Practical & Oral: 50 Marks

UNIT 1: Introduction to High Voltage Engineering (08 hours)

Electric Field Stresses, Gas/Vacuum as Insulator, Liquid Dielectrics, Solids and Composites, Estimation and Control of Electric Stress, Numerical methods for electric field computation, Surge voltages, their distribution and control, Applications of insulating materials in transformers, rotating machines, circuit breakers, cable power capacitors and bushings..

UNIT 2: Break Down in Dielectric Materials (08 hours)

Gases as insulating media, collision process, Ionization process, Townsend's criteria of breakdown in gases, Paschen's law. Liquid as Insulator, pure and commercial liquids, breakdown in pure and commercial liquids. Intrinsic breakdown, electromechanical breakdown, thermal breakdown, breakdown of solid dielectrics in practice, Breakdown in composite dielectrics, solid dielectrics used in practice.

UNIT 3: Generation and Measurement of High Voltages and Currents (10 hours)

Generation of High Direct Current Voltages, Generation of High alternating voltages, Generation of Impulse Voltages, Generation of Impulse currents, Tripping and control of impulse generators.
Measurement of High Direct Current voltages, Abrahm Voltmeter Measurement of High Voltages alternating and impulse, Measurement of High Currents-direct, alternating and Impulse, Oscilloscope for impulse voltage and current measurements.

UNIT 4: Over Voltages and Insulation Co-ordination (06 hours)

Natural causes for over voltages – Lightning phenomenon, Overvoltage due to switching surges, system faults and other abnormal conditions, Principles of Insulation Coordination on High voltage and Extra High Voltage power systems.

Unit 5: Testing Of Materials & Electrical Apparatus (08 hours)

Faraday cage, Significance and importance of FARADAY CAGE in HV labs, Measurement of D.C Resistivity, Measurement of Dielectric Constant and loss factor, Partial discharge measurements, Double frequency-Double voltage Testing of Instrument/ power Transformers, Testing of Pin type Insulators and bushings, Testing of Isolators and circuit breakers, testing of cables, Testing of Surge Arresters, and Radio Interference (EMI) measurements.

TEXT BOOKS:

1) High Voltage Engineering by M.S.Naidu and V. Kamaraju – TMH Publications, 3rd Edition.
2) High Voltage Engineering: Fundamentals by E.Kuffel, W.S.Zaengl, J.Kuffel by Elsevier, 2nd Edition.

REFERENCE BOOKS:

1) High Voltage Engineering by C.L.Wadhwa, New Age Internationals (P) Limited, 1997.
2) High Voltage Insulation Engineering by Ravindra Arora, Wolfgang Mosch, New Age International (P) Limited, 1995.
3) High Voltage Engineering, Theory and Practice by Mazen Abdel Salam, Hussein Anis, Ahdan El-Morshedy, Roshdy Radwan, Marcel Dekker

TERM WORK:

Minimum eight experiments based on above syllabus, preferably with uniform distribution.

1) Study of Faraday Cage for HV labs.
2) One min.(1-min.) DC high voltage withstand test on Equipment. (Max. up to 10 KV).
3) Demo of Impulse Voltage test on Elect. Equipment. (Max. 33 KV).
4) Effect of gap length on liquid insulating material.
5) Breakdown Strength of composite dielectric material.
6) Study of impulse generator.
7) High voltage withstand test on cables/safety gloves/shoes, as per IS. (Max. 2.25 KV DC)
8) Study of Horn gap arrangement as surge diverter.
9) Study of Measurement audible and visible corona inception and extinction voltage.
10) Study of Abraham Voltmeter.
11) Study of Sphere gap voltmeter.
12) Development of tracks and trees on polymeric insulation.
13) Study of Effect of EHV field on Human, Animals & Plants.

Industrial Visit: Industrial visit to high voltage equipment manufacturing industry.

EEP/452- POWER SYSTEM OPERATION & CONTROL.

Teaching Scheme:
Theory: 4Hrs/week
Practical: 2Hrs/week

Exam Scheme:
Theory Paper: 80 Marks
Class Test: 20 Marks
Practical & Oral: 50 Marks

UNIT 1: Synchronous Machine Modelling (8 hours)

Schematic diagram, Physical description: armature and field structure, machines with multiple pole pairs, MMF waveforms, direct and quadrature axes, Mathematical Description of a Synchronous Machine: Basic equations of a synchronous machine: stator circuit equations, stator self, stator mutual and stator to rotor mutual inductances, dq0 Transformation: flux linkage and voltage equations for stator and rotor in dq0 coordinates, electrical power and torque, physical interpretation of dq0 transformation, Park's transformation; Swing Equation, calculation of inertia constant, Simplifications for large-scale studies: Neglect of stator $p\Psi$ terms and speed variations, Simplified model with amortisseurs neglected: two-axis model with amortisseur windings neglected, classical model.

UNIT 2: Modelling of Excitation and Speed Governing System (7 Hours)

Excitation System Requirements; Elements of an Excitation System; Types of Excitation System; Control and protective functions; IEEE (1992) block diagram for simulation of excitation systems. Turbine and Governing System.

Modeling: Functional Block Diagram of Power Generation and Control, Schematic of a hydroelectric plant, classical transfer function of a hydraulic turbine (no derivation), special characteristic of hydraulic turbine, electrical analogue of hydraulic turbine, Governor for Hydraulic Turbine: Requirement for a transient droop, Block diagram of governor with transient droop compensation, Steam turbine modeling: Single reheat tandem compounded type only and IEEE block diagram for dynamic simulation; generic speed-governing system model for normal speed/load control function.

UNIT 3: Small signal Stability Analysis with/without Controller (7 hours)

Classification of Stability, Basic Concepts and Definitions: Rotor angle stability, The Stability Phenomena. Fundamental Concepts of Stability of Dynamic Systems: State-space representation, stability of dynamic system Single-Machine Infinite Bus (SMIB) Configuration: Classical Machine Model stability analysis with numerical example, Effects of Field Circuit Dynamics: synchronous machine, network and linearised system equations, block diagram representation with K-constants; expression for K-constants (no derivation), effect of field flux variation on system stability: analysis with numerical example Effects of Excitation System: Equations with definitions of appropriate K-constants and simple thyristor excitation system and AVR, block diagram with the excitation system, analysis of effect of AVR on synchronizing and damping components using a numerical example

UNIT 4: Economic Operation of Power System (5 hours)

Review of economic dispatch problem–Hydrothermal scheduling problem formulation- Long and short term problem mathematical model– optimal scheduling of hydrothermal system – solution by dynamic and incremental dynamic programming methods of local variation – pumped hydro storage plants. Factors considered in maintenance scheduling for generating units, turbines, boilers – Introduction to maintenance scheduling using mathematical programming.

UNIT 5: Reactive Power and Voltage Control (9 hours)

Production and absorption of reactive power- Methods of Voltage Control – Shunt reactors – Shunt Capacitors – Series Capacitors – Synchronous condensers – Static Var systems – Principles of Transmission system compensation – Modeling of reactive compensating devices – Application of tap changing transformers to transmission systems – Distribution system voltage regulation – Modelling of transformer ULTC control systems.

UNIT 6: Control of Power Systems (4 hours)

Review of AGC and reactive power control -System operating states by security control functions – Monitoring, evaluation of system state by contingency analysis – Corrective controls (Preventive, emergency and restorative) - Energy control center – SCADA system – Functions – monitoring , Data acquisition and controls – EMS system.

REFERENCES:

1) P. Kundur, “Power System Stability and Control”, McGraw-Hill, 1993.
2) IEEE Committee Report, "Dynamic Models for Steam and Hydro Turbines in Power System Studies”, IEEE Trans., Vol.PAS-92, pp 1904-1915, November/December, on Turbine-Governor Model, 1973.
3) P.M Anderson and A.A Fouad, “Power System Control and Stability”, Iowa State University Press, Ames, Iowa, 1978.
4) R. Ramanujam, “Power System Dynamics, Analysis and Simulation”, PHI Learning, New Delhi, January 2010.
5) Abhijit Chakrabarti, Sunita Halder, “Power System Analysis Operation and Control”, Prentice Hall of India.
6) I. J. Nagrath, D. P. Kothari, “Modern Power System Analysis”, Tata McGraw Hill Publishing Co. Ltd.
7) P. S. R. Murthy, “Power System Operation & Control”, Tata McGraw Hill Publishing Co. Ltd.

LIST OF PRACTICAL:

1) Simulation of single area and multi area LFC using MATLAB/ Simulink.
2) Modeling of AVR using MATLAB/ Simulink.
3) Small-signal stability analysis of single machine-infinite bus system using classical machine model.
4) Simulation of IEEE excitation systems.
5) Simulation of turbine and governor modeling.
6) Belgian Case Study: Power Flow Controlling Devices as a Smart and Independent Grid Investment for Flexible Grid Operations.
7) Case study of Real-Time Dynamic Security Assessment of Power Systems.

More Experiments may be designed as per the requirement and may be conducted on MATLAB/Simulink and/or any other software.

EEP/453- RENEWABLE ENERGY

Teaching Scheme:
Theory: 4 Hrs./Week.
Practical: 2hrs./Week.

Examination Scheme:
Theory Paper: 80 Marks
Class-Test: 20 Marks
Term Work: 50 Marks

UNIT 1: Energy sources & Availability [06 hours]

Conventional, Non-conventional, renewable, non renewable sources of energy, prospects & perspectives & advantages. Introduction to different types of non conventional source of energy - solar, wind, biomass, OTEC, geothermal, hydrogen energy, fuel cells, MHD, thermonic convertor, thermo-electric power.

UNIT 2: Solar Energy [08 hours]

Solar radiation, its measurement and prediction, Flat plate collectors: liquid and air type. Theory of flat plate collectors, advanced collectors, optical design of concentrators, selective coatings, solar water heating, solar dryers, solar stills, solar cooling and refrigeration, Thermal storage, Conversion of heat into mechanical energy , Active and passive heating of buildings, Solar cells.

UNIT 3: Wind Energy [08 hours]

Wind energy potential measurement, general theories of wind machines, basic laws and concepts of aerodynamics, aerofoil design; wind mill and wind electric generator. Description and performance of the horizontal–axis wind machines. Description and performance of the vertical–axis wind machines. The generation of electricity by wind machines, case studies.

UNIT 4: Biomass Energy [08 hours]

Introduction to biomass, biofuels & their heat content, biomass conversion technologies, Aerobic & anaerobic digester, Factors affection biogas, biogas plants - types & description. Utilization of biogas - Gasifiers, directs thermal application of Gasifiers. Advantages & problems in development of Gasifiers, use in I.C. engines.

UNIT 5: Other Energy Sources [10 hours]

Geothermal Energy: Status & estimates, geothermal sources, geothermal systems & their characteristics. Fuel Cells. Principle & Classification, types conversion efficiency, polarization & advantages, MHD power generation - principle, types closed & open cycle system materials. Energy form thermo nuclear fusion, OTEC, hydrogen, thermoionic generation & tidal waves.

TEXT BOOKS:

1) "Non-Conventional Sources of Energy," Rai G. D., Khanna Publishers, 4th Edition, 2007.

2) "Non-Conventional Energy Resources," Khan B. H., TMH, 2nd Edition.

REFERENCE BOOK:

1) "Fundamentals of Renewable Energy Systems," Mukherjee D. and Chakrabarti S., New Age International Publishers, 2005.

LAB EXPERIMENTS:

Experiments on Solar Energy

1) Single PV module I-V and P-V characteristics (with radiation and temperature changing effect)
2) I-V and P-V characteristics with series and parallel combination of modules.
3) Effect of shading and tilt angle.
4) Battery charging and discharging characteristics.
5) Demo of only DC load system with and without battery. (with variable rated capacity of system)
6) Demo of only AC load system with and without battery.
7) Combine AC and DC load system with and without battery.
8) Find the MPP manually by varying the resistive load across the PV panel.
9) Find the MPP by varying the duty cycle of DC-DC converter.

More Experiments may be designed as per the requirement and may be conducted on MATLAB/Simulink and/or actual implementation.

EEP/491- Elective-II: ELECTRICAL POWER QUALITY

Teaching Scheme	Exam Scheme
Lecture: 4 Hrs/week	Paper: 80 Marks
Practical: 2 Hrs/week	Class Test: 20 Marks
	Term work: 50 Marks

The objective of this subject is to aware the students about the Quality of the Power being transmitted in terms of different power quality issues and different IEEE and IEC standards related to it such that students should be able to monitor, identify and rectify the problems in the application causing power quality disturbances.

UNIT I. Introduction (08 Hours)

Understanding Power quality, definitions, growing concerns to Power Quality, Evaluation Procedure, General Classes of Power Quality disturbances, causes and effects of Power Quality disturbances

UNIT 2: Power Quality Disturbances (08 Hours)

a) Voltage Sag and Interruptions: causes and effects, estimation of voltage sag performance, principle of protection and solutions

b) Transient Over voltages: Sources, causes and effects, Principle of Overvoltage protection, solutions

c) Long Duration Voltage variations, principles of regulating voltage devices for voltage regulation, flickers, flicker sources and mitigation, quantifying flicker.

UNIT 3: Harmonics (08 Hours)

Harmonic distortion, sources of harmonics, effects of harmonic distortion, Voltage Vs Current Harmonics, Active, Reactive, Volt-Amp power under non sinusoidal conditions, Harmonic Indices (THD and TDD), principles of harmonic control, mitigating devices, interharmonics, IEEE standard 519.

UNIT 4: Wiring and Grounding (04 hours)

Reasons for Grounding, wiring and grounding problems and solutions

UNIT 5: Power Quality Monitoring (06 Hours)

Monitoring Considerations, site survey, Monitoring Qualtity, monitoring location, PQ measuring instruments, assessment of power quality measurement data, IEEE 1159 Standard

UNIT 6: Power Quality Reliability (06 Hours)

Impact of poor power quality on Reliability, Security and Relaying:

Reliability Indices, Degradation of Reliability and security due to poor Power Quality

REFERENCE BOOKS:

1) Power Quality – R.C. Dugan, Tata McGraw Hill Publications.

2) Understanding Power Quality Problems – Math J. Bollen, Wiley Publication.
3) Power Quality in Power Systems and Electrical Machines - Ewald Fuchs, Mohammad A. S. Masoum, Elsevier Academic Press.
4) Power System Harmonics – A.J. Arrilliga.
5) IEEE standards 519 and 1159.

TERM WORK:

Term Work shall consists of four experiments from the list given below and shall be based on MATLAB/PSCAD software based simulations

1) Generation of different power quality disturbances.
2) Simulation of mitigating device for voltage sag.
3) Simulation of mitigating device for overvoltages/transients.
4) Simulation of harmonic producing load and mitigating filter.
5) Site survey for PQ analysis using PQ monitoring instruments.

EEP/492- Elective-II: ELECTRIC TRACTION & UTILIZATION

Teaching Scheme	Exam Scheme
Lecture: 4 Hrs/week	Paper: 80 Marks
Practical: 2 Hrs/week	Class Test: 20 Marks
	Term Work: 50 Marks

UNIT 1: Electric Traction System (07hours)

Electrical transmission: Electrical transmission system employing D.C. generator D.C. series motor, Electrical transmission system employing 3 phase alternator supplying D.C. traction motors, electrical transmission employing 3 phase alternator supplying induction motors, Choice of traction system-battery drive, hybrid drive, flywheel drive, tramways, trolley bus.

Track electrification: D.C. System, single phase low frequency A.C. system, single phase high frequency A.C. system, 3 phase A.C. system and composite system.

UNIT 2: Power Supply for Electric Traction (08 hours)

Current collection system, current collectors for Over Head Systems, Over head construction for Tramways and trolley buses and railways, Sag and Tension calculation for a trolley wire, Traction substations, location of substations, feeding and distributing system, substation equipments. Block Diagram of AC Electric locomotive, Signalling interference in tele-communication circuits.

UNIT 3: Traction Motors (08 hours)

Characteristics of traction motors, straight D.C. series motor, suitability of series motor for traction duty, constructional details of D.C. Traction Motors, Series motor using undulating D.C, suitability of shunt motor for traction duty, single phase series motors, Repulsion motor, compensated repulsion motor, Induction motor with variable frequency with SCR, Linear Induction motor.

UNIT 4: Traction Control (08 hours)

Traction control: Duty cycle, Methods of traction motor control, series-Parallel and other types of controllers, use of interlocks, run back prevented, multiple unit control, Master controllers, Reverses, Dead man's handle, use of Metadyne and Megavolt.

UNIT 5: Train Movement and Braking (06 hours)

Speed time curve, its analysis and construction, schedule speed and factors affecting it, train resistance and its components. Tractive effort calculations, average acceleration and speed, energy output and consumption.

Braking: Mechanical versus electric breaking, rheostatic braking, Regenerative braking, method and energy saved in the process, Magnetic track brakes.

UNIT 6: Refrigeration and Air Conditioning (03 hours)

Refrigeration system, domestic Refrigerator, Water cooler, Types of Air conditioning, Room air conditioners, central air conditioning systems.

REFERENCE BOOKS:

1) H. Partab: Modern Electric traction, Dhanpat Rai & sons.
2) Upadhayay J. & Mahindra S.N., Electric Traction, Allied Publishers Ltd., 1st Ed.
3) Rao P.S., Principle of 25 KV Overhead Equipments. R. (Nasik) Printpack Pvt Ltd,, 1st Ed.
4) Electric Traction for Railway Trains, by Edward P. Burch. McGraw Hill Book Co. Inc.
5) C.L.Wadhwa, "Generation, Distribution and Utilization of Electrical Energy", New Age International Publishers.
6) Electrical Power by J.B. Gupta.

TERM WORK:

Term work shall consist of a field visit to locomotive employed with Electric traction. Submit a project report depicting Electric Traction.

And

Term work shall consist of record of experiments from the following:

1) Field visit to locomotive employed with Electric Traction.
2) Study of an electric locomotive by visiting any railway repair shop at a nearby station.
3) Study of refrigerator and to prepare a report of its electrical circuit.
4) Study of air conditioner and to prepare a report of its electrical circuit.
5) Drawing layout on Electric traction power supply feeding.

EEP/493- Elective-II: ELECTRICAL SYSTEM PLANNING & DESIGN

Teaching Scheme
Lecture: 4 Hrs/week
Practical: 2 Hrs/week

Exam Scheme
Paper: 80 Marks
Class Test: 20 Marks
Term Work 50 Marks

UNIT 1: Design of Simple Electrical Circuits (04 hours)

Introduction, simple light and fan circuits, system of connection and accessories, solved examples on light and fan circuits, introduction of simple alarm circuits without and with relays.

Unit 2: Design of Power and Control Circuit Installation (08 hours)

Introduction, Design consideration of Electrical installation, Protection devices such as fuse, Earthing and requirements such as Soil Resistivity, Electrode, Types of earthing, Single phase and three phase installation for residential load, Busbar and Busbar chambers, Mounting of CTs and PTs.

UNIT 3: Design of Illumination Schemes (06 hours)

Introduction, Terminology in Illumination, Laws of Illumination, Various types of Light Sources, Practical lighting schemes, solved examples on lighting scheme.

UNIT 4: Substation (08 hours)

Introduction, Types of substation, Equipment and Accessories, Outdoor substation-pole mounting type and their SLD & estimation, Indoor substation- floor mounting type and their SLD & estimation.

UNIT 5: Electrical Installation for Different Types of Building and Small Industries (06 hours)

Electrical installation for commercial buildings, Electrical installation for small industries, PFC and APFC panel installation.

UNIT 6: Motor Control Circuits (08 hours)

Starting of 3- phase squirrel cage induction motor, Starting of multi speed squirrel cage induction motor, starting of wound rotor motor, starting of synchronous motor, Stopping of motor, Contactor-relay logic control circuit components and wiring, schematic, ferruling relay boards, connector boards etc.

TEXTBOOKS:

1) Electrical Design Estimating And Costing by K.B. Raina, S.K. Bhattacharya, New Age international LTD Publishers.
2) Electrical Wiring - Estimating & Costing By S.L. Uppal, Khanna Publishers.
3) Electrical Installation Estimating & Costing By J.B. Gupta, S.K. Kataria & Sons Publishers.
4) Residential, Commercial and Industrial Electrical Systems by Hemant Joshi, Tata Mcgraw-Hill Publishers.

5) Performance & Design of A.C. Machines by M.G.Say, CBS Publishers.
6) Performance & Design of D.C. Machines by A. E. Clayton & N. N. Hancock CBS Publishers.

REFERENCE BOOK:

1) Manual of Auto CAD.

TERM WORK:

Electrical Drawing using design data or sketches or Computer Aided Electrical Drawing

(a) Drawing sheet on problems solved on the topics of each unit.

(b) Drawing sheet on Single line diagram of generating station and substation.

Or

1) Electrical Drawing using design data or sketches or both
   a) Drawing on problems solved in the topics of each unit.
   b) Transformer -sectional views of single and three phase core and shell type transformer.
   c) D.C. Machine- sectional views of yoke, field system, armature and commutator.
   d) Alternator- sectional views of stator and rotor.

2) Winding Diagrams
   a) D.C. Machine- Simplex and multiplex double layer lap and wave windings
   b) A.C. Machine- Single layer windings- Un-bifurcated 2 and 3 tier windings, mush winding, Integral and fractional slot double layer lap and wave winding

EEP/494- Elective-II: ILLUMINATION ENGINEERING

Teaching Scheme
Lecture: 4 Hrs/week
Practical: 2 Hrs/week

Exam Scheme
Paper: 80 Marks
Test: 20 Marks
Term Work: 50 Marks

UNIT 1: Fundamentals of Illumination (06 hours)

Light and Electromagnetic Radiation: What is Light? , The "Visible" Spectrum, Ultraviolet Radiation, Infrared Radiation. Basic Concepts in Optics : Reflection, Refraction (Snell's law),Reflection and the Index of Refraction , Total Internal Reflection (TIR) , Dispersion, Transmission, Absorption, Diffusion (Scattering), Filtering. Basic Radiometric and Photometric Principles: Basic Radiometric and Photometric Quantities, Spectral Response , Solid Angle, Radiant and Luminous Energy and Energy Density , Radiant and Luminous Flux ,Spectral Luminous Efficacy, Radiant Existence, Irradiance (Radiant Incidence) and illuminance ,Radiance and Luminance, Radiant and Luminous Intensity

UNIT 2: Importance of Lighting (06 hours)

Optical systems of human eye ,Dependence of human activities on light, performance characteristics of human visual system, External factors of vision-visual acuity, contrast ,sensitivity, time luminance, color, visual perception, optical radiation hazards, Good and bad effects of lighting & perfect level of illumination, Artificial lighting as substitute to natural light, Ability to control natural light, Production of light, physics of generation of light, Properties of light, Quantification & Measurement of Light.

UNIT 3: Light Source (08 hours)

Lamp materials: Filament, glass, ceramics, gases, phosphors and other metals and non-metals. Discharge Lamps: Theory of gas Discharge phenomena, lamp design considerations, characteristics of low and high mercury and sodium vapor lamps, Low Vapor Pressure discharge lamps - Mercury Vapour lamp, Fluorescent Lamp, Compact Fluorescent Lamp (CFL), High Vapour Pressure discharge lamps - Mercury Vapour lamp, Sodium Vapour lamp, Metal halide Lamps, Solid Sodium Argon Neon lamps, SOX lamps, Electro luminescent lamps, LEDs characteristics, features and applications, LASERS, characteristics, features and applications, non-lighting lamps, Induction lamps. Optical fiber, its construction as a light guide, features and applications.

Electrical Control of Light Sources: Ballast and ignitors for different HID lamps, design considerations of Electromagnetic and Electronic ballast for TL and HID lamps, Ballast material, Dimming.

UNIT 4: Photometric Control of Light Sources (08 hours)

Basic Radiometric and Photometric Measurement : The Inverse Square Law , Lambert's Cosine Law, Lambertian Emission and Reflection ,Light Sources, Incandescent Lamps Spectrum and Color, Optical Modeling schemes , Ray Tracing, Sequential Ray Tracing, Non sequential Ray Tracing, Computer Modeling Design Steps ,Construction and working principale of spectroradiometer, spectrophotometer

& colorimeter, Luminaries design considerations, optical control schemes, design procedure of reflecting and refracting type of luminaries. Lighting Fixture types, use of reflectors and refractors, physical protection of lighting fixtures, Types of lighting fixtures according: installation type & photometric usages, ingress protection code, luminaries standard. Indian standard recommendations.

UNIT 5: Lighting Design (08 hours)

Indoor Lighting Design**:** Zonal cavity method for general lighting design, coefficient of utilization determination for zonal cavities and different shaped ceilings. Using COU (coefficient of utilization), using beam angles and polar diagrams, glare calculations. Typical applications: office, educational facility, theatre, residential, hospital. Indian Standard recommendation for indoor lighting, selection criteria for selection of lamps and luminaries, design consideration and design procedure. (Problems on COV, beam angles and polar diagrams).

Outdoor Lighting Design: Road classifications according to BIS, pole arrangement, terminology, lamp and luminaire selection, different design procedures, beam lumen method, point by point method, isolux diagram, problems on point by point method.

UNIT 6: Condition based Lighting (04 hours)

Energy Efficient Lighting: Comparison between different light sources, comparison between different control gears, overcoming problems in energy efficient lighting, payback calculation, life cycle costing, (problems on payback calculations, life cycle costing) Solar Lighting: Day Lighting, Photovoltaic Lighting. Emergency Lighting: Central Systems, Stand alone systems. Cold Lighting: Concept, Method of generation – Optical Fiber cable (OFC), filters, Application. Switching Control for Lighting. Typical Lighting Project Design: New projects, Retrofits

TEXT BOOKS:

1) H. S. Mamak, “Book on Lighting”, Publisher International lighting Academy.
2) Joseph B. Murdoch, “Illumination Engineering from Edison’s Lamp to Lasers”
3) M. A. Cayless, A. M. Marsden, “Lamps and Lighting”
4) Author: Alma E. F. Taylor, “Illumination Fundamentals”

REFERENCE BOOKS:

1) “BIS, IEC Standards for Lamps, Lighting Fixtures and Lighting”, Manak Bhavan, New Delhi
2) D. C. Pritchard, “Lighting”, 4th Edition, Longman Scientific and Technical, ISBN 0-582-23422-0
3) Elmer, “Design of Reflectors”
4) “IES Lighting Handbook”, (Reference Volume 1984), Illuminating Engineering Society of North America.
5) “IES Lighting Handbook”, (Application Volume 1987), Illuminating Engineering Society of North America.

TERM WORK:

Minimum 8 experiments should be conducted.

1) Measurement of Light.
2) LED Intensity Measurements
3) Electrical Control of Light Sources
4) Planning of Lighting Scheme
5) Design of Indoor Lighting Scheme
6) Design of Industrial Lighting Scheme
7) To study Airport Lighting
8) To study the Laws of Illumination and illumination from point
9) To study Indoor Stadium Lighting
10) To study Photovoltaic Lighting

EEP/495- Elective-II: CONTROL SYSTEM II

Teaching Scheme	Examination Scheme
Theory: 4 Hrs/Week	Paper: 80 Marks
Particles: 2 Hrs/Week	Class Test: 20 Marks
	Term-Work: 50 Marks

UNIT 1: State Variable Analysis (08 hours)

Solution of State Equation, State Transition Matrix and its Properties, Computation using Laplace Transformation, Power Series method, Cayley-Hamilton method, Diagolization, Eigen values, Eigen vectors, Generalized Eigen vectors.

UNIT 2: Pole Placement Techniques (08 hours)

Stability improvements by State Feedback, Necessary and Sufficient Conditions for Arbitrary Pole Placement, State Regulator Design and Design of State Observer.

UNIT 3: Digital Control Systems (08 hours)

Introduction to discrete time systems, necessary for Digital Control system the Z transforms, and the inverse Z transform Pulse transfer function, time response of sampled data systems, stability using Jury criterion, bilinear transformation.

UNIT 4: Nonlinear Control System (04 hours)

Introduction, Behavior of Non-Linear System, Common Physical Nonlinearities, Friction, Backlash, Dead-Zone, Relay, Multivariable Nonlinearity.

UNIT 5: Lyapunov Stability (06 hours)

Lyapunov Stability Criteria, Lyapunov function, Direct Method of Lyapunov and Linear System, Hurwitz Criterion and Lyapunov Direct method, Construction of Lyapunov function for Nonlinear System by Kravskii's method.

UNIT 6: Intelligent Control System (06 hours)

Fuzzy Logic Control, Fuzzy Sets verses Crisp Sets, Fuzzy Set Theory And Operations, Fuzzy Knowledge Based Control System (FKBC), Neural Networks, Artificial Neuron Model, Multi Layer Network, Back Propagation Algorithm.

TEXT BOOKS:

1) Control system Engineering, I. J. Nagarath & M. Gopal, New Age International (P) Ltd, 3rd Edition.
2) Digital control & state variable methods, M. Gopal , 3rd Edition, TMH ,2008

REFERENCE BOOKS:

1) Control System, A. Nagoor Kani-RBA Publications.
2) State Space Analysis of Control Systems, Katsuhiko Ogata –PHI.
3) Automatic Control Systems, Benjamin C. Kuo & Farid Golnaraghi, 8th Edition, John Wiley & Sons 2009.
4) Modern Control Engineering, Katsuhiko Ogata, PHI, 5th Edition, 2010.
5) Control System Engineering, Norman Nice, New Age Publishers.

TERMWORK:

Term-work shall consist of minimum EIGHT experiments from above UNITS.

EEP/496- Elective-II: EMBEDDED SYSTEM

Teaching Scheme
Lecture: 4 Hrs/week
Practical: 2 Hrs/week

Exam Scheme
Paper: 80 Marks
Test: 20 Marks
Term work: 50 Marks

UNIT 1: Embedded System Introduction (08 hours)

Introduction to Embedded System, History, Design challenges, optimizing design metrics, time to market, applications of embedded systems and recent trends in embedded systems, embedded design concepts and definitions, memory management, hardware and software design and testing, communication protocols like SPI, I2C, CAN etc.

UNIT 2: System Architecture (12 hours)

Introduction to ARM core architecture, ARM extension family, instruction set, thumb Instruction set, Pipeline, memory management, Bus architecture, study of on-chip peripherals like I / O ports, timers, interrupts, on-chip ADC, DAC, RTC modules, WDT, PLL, PWM, USB, I2C, SPI, CAN etc. Use 2148 /2368/2378 as reference micro-controllers

UNIT 3: Interfacing and Programming (10 hours)

Basic embedded C programs for on-chip peripherals studied in system architecture. Need of interfacing, interfacing techniques, interfacing of different displays including Graphic LCD, interfacing of input devices including touch screen etc, embedded communication using SPI,I2C, GSM modem for AT command study etc.

UNIT 4: Real Time Operating System Concept (10 hours)

Architecture of kernel, task scheduler, ISR, Semaphores, mailbox, message queues, events, memory management, RTOS services in contrast with traditional OS. Introduction to Ucos II RTOS, study of kernel structure of Ucos II, synchronization in Ucos II, Inter-task communication in Ucos II, memory management in Ucos II, porting of RTOS.

TEXT/REFERENCE BOOKS:

1) Rajkamal - Embedded Systems, TMH.
2) David Simon - Embedded systems software primer, Pearson
3) Steve Furber - ARM System-on-Chip Architecture, Pearson
4) Jean J Labrose - MicroC / OS-II, Indian Low Price Edition
5) DR.K.V.K.K. Prasad - Embedded / real time system, Dreamtech
6) Iyer, Gupta - Embedded real systems Programming , TMH
7) Steve Heath - Embedded System Design , Neuwans
8) ARM System Developers Guide – Andrew Sloss

TERMWORK:

Term-work shall consist of minimum EIGHT experiments from above UNITS.

EEP/497- Elective-II: OPEN ELECTIVE-II

Teaching Scheme	Examination Scheme
Theory: 4 Hrs/Week	Paper: 80 Marks
Particles: 2 Hrs/Week	Class Test: 20 Marks
	Term Work: 50 Marks

Same as Open Elective-I students are allows to design the syllabus of a subject of his own choice and then introduce the subject as an Elective Subject into the curriculum so that students can then option for this subject as an Elective subject (i.e. Elective-II).

EEP/475- PROJECT PART-II

Teaching Scheme
Practical: 6 Hrs/week

Exam Scheme
Term Work: 50 Marks.
Practical & Oral: 100 Marks.

Project Part-II will be continuation of project Part-I under taken by the candidates in the first term and complete project in all respect (assembly, testing, fabrication, tabulation, test result etc.). The project work shall consist of a typed report on the work carried out by a batch of students in respect of the project assigned during the first term Part-I and the second term Part-II.

The Practical Examination consists of an oral examination based on the report submitted by the candidates and or the demonstration of the designed project. The said examination will be conducted by a panel of Examiners consisting of preferably the internal guide and other External Examiner appointed by University.