M. Tech (PT) Degree Course

in

ELECTRICAL AND ELECTRONICS ENGINEERING
(Specialization: Power Electronics)

SCHEME OF EXAMINATIONS & SYLLABUS
(With effect from 2019 Admissions)

SCHOOL OF ENGINEERING
COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY
KOCHI– 682 022

March – 2019

1.5.3 ELECTRICAL AND ELECTRONICS ENGINEERING
(Specialization: Power Electronics)

Scheme of Examination

SEMESTER I

Course Code	*Subject*	*No of Credits*
EEP 3101	Applied Mathematics	3
EEP 3102	Power Electronics Circuits	3
EEP 3103	Modern Control Theory	3
EEP 3104	Electric drives	3
EEP 3105	Seminar I	1
Total		13

SEMESTER II

Course Code	*Subject*	*No of Credits*
EEP 3201	Advanced Power Electronics Circuits	3
EEP 3202	Distributed energy systems	3
EEP 3203	Power Quality	3
EEP 3204	Elective I	3
EEP 3205	Seminar II	1
Total		13

Elective I

EEP 3204 A	Advanced Digital Signal Processing
EEP 3204 B	Special Electric Machines & Control
EEP 3204 C	Modern Communication Engineering
EEP 3204 D	Microcontroller Based Systems

SEMESTER III

Course Code	*Subject*	*No of Credits*
EEP 3301	Energy Management in Electrical System	3
EEP 3302	Solar Photovoltaic systems	3
EEP 3303	HVDC and FACTS	3
EEP 3304	Elective II	3
EEP 3305	Seminar III	1
Total		13

Elective II

EEP 3304 A	Statistical methods for engineering
EEP 3304 B	Process Control & Automation
EEP 3304 C	Dynamics of Electric Machines
EEP 3304 D	Reliability

SEMESTER IV

Course Code	*Subject*	*No of Credits*
EEP 3401	Power electronic Converters for Distributed Energy Systems	3
EEP 3402	Elective III	3
EEP 3403	Elective IV	3
EEP 3404	Project – Preliminary Evaluation	2
Total		11

Elective III

EEP 3402A	Research Methodology
EEP 3402B	Soft computing
EEP 3402C	Digital Simulation of Power electronic Systems
EEP 3404D	Industrial Instrumentation

Elective IV

EEP 3403A	Smart Grid Technologies & Applications
EEP 3403B	Hybrid & Electric vehicle
EEP 3403C	SCADA Systems & Applications
EEP 3403D	Digital Control System

SEMESTER V

Course Code	*Subject*	*No of Credits*
EEP 3501	Project -Progress Evaluation	10
Total		10

SEMESTER VI

Course Code	*Subject*	*No of Credits*
EEP 3601	Project -Dissertation Evaluation &Viva Voce	12
Total		12
Grand Total		72

M.Tech (PT) Electrical & Electronics Engineering

(Power Electronics)

Syllabus

EEP 3101: APPLIED MATHEMATICS

Course outcomes:
CO1: Acquire knowledge about vector spaces, linear transformation, eigenvalues and eigenvectors of linear operators.
CO2: To learn about linear programming problems and understanding the simplex method for solving linear programming problems in various fields of science and technology.
CO3: Acquire knowledge about nonlinear programming and various techniques used for solving constrained and unconstrained nonlinear programming problems.
CO4: Understanding the concept of random variables, functions of random variable and their probability distribution.
CO5: Acquire knowledge about stochastic processes and their classification.

Module 1:

Vector spaces, subspaces, Linear dependence, Basis and Dimension, Linear transformations, Kernels and Images , Matrix representation of linear transformation, Change of basis, Eigen values and Eigen vectors of linear operator

Module 2
Mathematical formulation of Linear Programming Problems, Simplex Method, Duality in Linear Programming, Dual Simplex method.

Module 3

Non Linear Programming preliminaries, Unconstrained Problems ,Search methods , Fibonacci Search, Golden Section Search, Constrained Problems , Lagrange method ,Kuhn-Tucker conditions

Module 4

Random Variables, Distributions and Density functions, Moments and Moment generating function, Independent Random Variables, Marginal and Conditional distributions, Conditional Expectation, Elements of stochastic processes, Classification of general stochastic processes.

Text Books and References:
1. Kenneth Hoffman and Ray Kunze, Linear Algebra,2nd Edition, PHI, 1992.
2. Erwin Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, 2004.
3. Irwin Miller and Marylees Miller, John E. Freund's Mathematical Statistics, 6th Edn, PHI, 2002.
4. J. Medhi, Stochastic Processes, New Age International, New Delhi., 1994

5. A Papoulis, Probability, Random Variables and Stochastic Processes, 3rd Edition, McGraw Hill, 2002
6. John B Thomas, An Introduction to Applied Probability and Random Processes, John Wiley, 2000

EEP 3102: POWER ELECTRONIC CIRCUITS

Course outcomes:

CO1:Acquire knowledge about analysis and design of various types of DC Chopper circuits
CO2: Acquire knowledge about various PWM techniques of 2-level DC to AC converters
CO3: Acquire knowledge about analysis of multilevel inverters with advanced PWM techniques.
CO4: Acquire knowledge about various types of controlled rectifiers
CO5: To learn the basics of power semiconductor switches.

Module 1

D.C.chopper circuits, Type-A, B, C, D and E configurations, Analysis of Type-A chopper with R-L load. Voltage and current commutated Choppers
Phase-Controlled Rectifiers -Single Phase - Half Wave Controlled RectifierwithR , RL , RL with Flywheel diode loads . Full Wave Controlled Rectifier with various kinds of loads .Half Controlled and Full Controlled Bridges with passive and active loads
Inverter Mode of Operation - Three Phase . Half Wave Controlled rectifier with RLLoad . Half Controlled Bridge with RL Load . Fully Controlled Bridge with RL Load - Dual Converters . Circulating Current Mode and Non-Circulating CurrentMode .

Module 2

Switch-Mode dc-ac Inverters . Basic Concepts . Single Phase Inverters. PWM Principles . Sinusoidal Pulse Width Modulation in Single Phase Inverters - Bipolar and Unipolar Switching in SPWM
Three PhaseInverters -Three Phase Square Wave /Stepped Wave Inverters . Three Phase SPWM Inverters . Choice ofCarrier Frequency in Three Phase SPWM Inverters . Output Filters . DC Side Current . Effect of BlankingTime on Inverter Output Voltage .
Multi-Level Inverters -Diode ClampedType, Flying Capacitor Type and cascaded type - suitable modulation strategies -Space Vector Modulation – Minimumripple current PWM method

Module 3

Power Diodes . Basic Structure and I-V Characteristics .-Switching Characteristics . -SchottkyDiodes-Snubber Requirements for Diodes
Power BJTs . Basic Structure and I-V Characteristics . Breakdown Voltages and Control - Switching Characteristics . Resistive Switching Specifications - Base Drive Requirements . Switching Losses . Device Protection- Snubber. Requirements for BJTs and Snubber Design
Power MOSFETs - Basic Structure . V-I Characteristics . Turn on Process . On State operation . Turn offprocess . Switching Characteristics .

Insulated Gate Bipolar Transistors (IGBTs) . Basic Structure and Operation .Latch up IGBT SwitchingCharacteristics . Resistive Switching Specifications . - Overcurrent protection of IGBTs . Short Circuit Protection .Snubber Requirements andSnubber Design.

Module 4

Thermal design of power electronic equipment .Modelling of powersemiconductors (principles) . Gating Requirements for Thyristor, Component Temperature Control and Heat Sinks . Control of devicetemperature - heat transfer by conduction - transient thermal impedance - heat transfer byradiation and convection - Heat Sink Selection for SCRs and GTOs. Modelling of power diode - Modelling of power MOSFET - Modelling of bipolar transistor - Modelling ofIGBT

Text Books and References:

1. Ned Mohan et.al ,"Power Electronics",John Wiley and Sons,2006
2. G. Massobrio, P. Antognet," Semiconductor Device Modeling with Spice", McGraw-Hill, Inc.,1988.
3. B. J. Baliga," Power Semiconductor Devices",Thomson, 2004.
4. V. Benda, J. Gowar, D. A. Grant," Power Semiconductor Devices. Theory and Applications", John Wiley & Sons1994.99

EEP 3103: MODERN CONTROL THEORY

Course outcomes:

CO1 :To determine various properties of these systems including controllability, observability, and stability.
CO2 : To apply the knowledge of basic and modern control system for the real time analysis and design of control systems.
CO3 : To analyze the concept of stability of nonlinear systems and Formulate optimal control problem

Module 1

Concepts of controllability and observabiity: Controllability and observabiity tests for continuous and discreet times systems, controllability and observabiity studies based on canonical forms of state model, concepts of stability of non-linear systems, second method of Lyapunov, Krasovskial method.

Module 2

Model control: Controllable and observable companion forms, effect of state feedback on controllability and observabiity, pole placement by state feedback, full order and reduced order observers, design of observers.

Module 3

Optimal control theory: Formulation of optimal control problem, state regulator problem, output regulator problem, tracking problem, Parameter optimisation.

Module 4

Optimal feedback control : Discrete and continuous time state regulators, Numerical solution of the Riccati equation, linear state regulator to solve other linear optimal control problems, sub optimal regulators.
Non linear Control, Model reference adaptive control, Sliding mode control.

Text book and References :

1. M. Gopal, Digital Control and State Variable Method', Tata McGraw Hill 3rd . edition 2009

2. I. J. Nagrath, M. Gopal, 'Control System Engg.', New age 5th Edition 2007.

3. G.C. Goodwin, S.F. Graebe, 'Control System Design Prentice Hall, 2001',

4. A.K. Tripathi, Dinresh Chandra, 'Control System Analysis and Design' New age International1st Edition 2009.

5. Richard C. Dorf, Robert H. Bishop, Modern Control Systems, Addison-Wesley, 8th Edition 1999.

EEP 3104: ELECTRIC DRIVES

Course outcomes :

CO1: Develop capability to choose a suitable Motor and Power Electronic Converter package from a description of drive requirement – involving load estimation, load cycle considerations, thermal aspects and motor-converter matching

CO2: To learn about various DC and AC machines used in drives.

CO3: Acquire detailed knowledge of Electrical Motor operation using Generalized machine theory.

CO4: To understand the working and design of various converters used in Electrical Drives.

Module – 1

Introduction to Electric Drives – advantages – parts of electric drives - dynamics of electric drive - torque equation – four quadrant operation - equivalent values of drive parameters- classification of load torques - steady state stability - load equalization - Classes of motor duty- determination of motor rating.

Module – 2

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DC motor drives – starting – regenerative braking, dynamic braking, plugging – Transient analysis of separately excited motor – speed control – controlled rectifier fed DC drives – single phase fully controlled & half controlled rectifier control of separately excited DC motor – discontinuous and continuous conduction - three-phase fully controlled & half controlled rectifier control separately excited DC motor

Module – 3

Induction motor drives – 3-phase induction motor - torque equation – analysis with unbalanced source voltages and single-phasing – analysis of induction motor fed from non-sinusoidal voltage supply – regenerative braking, pugging, dynamic braking – speed control – pole changing – stator voltage control – static rotor resistance control - stator frequency control below and above base speed

Module – 4

Synchronous motor drives – cylindrical rotor and salient pole types – torque equation – power factor control – operation with non-sinusoidal supply - speed control of synchronous motors – true synchronous mode and self controlled mode – rotor position encoder – load commutated synchronous motor drive – closed loop speed control – line commutated cycloconverter fed synchronous motor drive.

Text Books and References :

1. *P.C Sen 'Thyristor DC Drives', John wiely and sons, New York, 2001.*
2. *R.Krishnan, 'Electric Motor Drives - Modeling, Analysisuxnd Control', Prentice-Hall of India Pvt Ltd., New Delhi, 2003.*
3. *Bimal K.Bose, 'Modern Power Electronics and AC I Drives', Pearson Education (Singapore) Pte. Ltd., New Delhi, 2003.*
4. *GK Dubey, "Fundamentals of Electrical Drives", Narosa*

EEP 3201: ADVANCED POWER ELECTRONIC CIRCUITS

Course Outcomes:
CO1: Acquire knowledge about analysis and design of Load Commutated CSI and PWM CSI
CO2: Acquire knowledge about analysis and design of series Inverters.
CO3: Acquire knowledge about analysis and design of Switched Mode Rectifiers and APFC
CO4: Acquire knowledge about analysis and design of isolated and nonisolated Switched Mode DC to DC Converters
CO5: Acquire knowledge about analysis and design of Resonant Converters

Module 1

Special Inverter Topologies - Current Source Inverter . Ideal Single Phase CSI operation, analysis and waveforms - Analysis of Single Phase Capacitor Commutated CSI.
Series Inverters . Analysis of Series Inverters . Modified Series Inverter . Three Phase Series Inverter

Module 2

Switched Mode Rectifier - Operation of Single/Three Phase bilateral Bridges in Rectifier Mode .ControlPrinciples . Control of the DC Side Voltage . Voltage Control Loop . The inner Current ControlLoop.
Single phase and three phase boost type APFC and control, Three phase utility interphases andcontrol

Module 3

Buck, Boost, Buck-Boost - SMPS Topologies . Basic Operation- Waveforms - modes of operation - Push-Pull and Forward Converter Topologies - Basic Operation . Waveforms - Half and Full Bridge Converters . Basic Operation and Waveforms- FlybackConverter .discontinuous mode operation .waveforms- Continuous Mode Operation .Waveforms .
Voltage Mode Control of SMPS . Loop Gain and Stability Considerations . Shaping the Error Amp frequency Response . Error Amp Transfer Function . Current Mode Control of SMPS . Current Mode Control Advantages . Current Mode Vs Voltage Mode .

Module 4

Introduction to Resonant Converters . Classification of Resonant Converters . Basic Resonant Circuit Concepts . Load Resonant Converter . Resonant Switch Converter . Zero Voltage Switching Clamped Voltage Topologies . Resonant DC Link Inverters with Zero Voltage Switching . High Frequency LinkIntegral Half Cycle Converter.
Matrix converter – principle – matrix converter switches - 3-phase matrix converter – switching control strategy - commutation and protection issues in matrix converter

Textbooks and References:

1. Ned Mohan et.al “Power electronics : converters, applications, and design” John Wiley and Sons, 2006
2. Rashid “Power Electronics” Prentice Hall India 2007.
3. G.K.Dubey et.al “Thyristorised Power Controllers” Wiley Eastern Ltd., 2005, 06.
4. Dewan&Straughen “Power Semiconductor Circuits” John Wiley &Sons., 1975.
5. G.K. Dubey& C.R. Kasaravada “Power Electronics & Drives” Tata McGraw Hill., 1993.
6. IETE Press Book Power Electronics Tata McGraw Hill, 2003
7. Cyril W Lander “Power Electronics” McGraw Hill., 2005.
8. B. K Bose “Modern Power Electronics and AC Drives” Pearson Education (Asia)., 2007

EEP 3202: Distributed Energy Systems

Course Outcome

CO1 : To understand the fundamentals of solar energy and its radiation, collection, storage and application.
CO2 : To familiarize photovoltaic cells and different Instruments for measurement of solar radiation
CO3 : To understand fundamentals of the wind energy, Biomass energy, geothermal energy and ocean energy as alternative energy sources.
CO4 : Acquire knowledge in biomass conversion and types of fuel cells

Module 1

Distributed Generarion(DG) – Introduction – Reasons for DG – Technical Impacts – Economic Impact – Barriers to DG development

Introduction to energy conversion principle of renewable energy systems: Technical and social implications; Solar energy. Overview of solar energy conversion methods. Solar radiation components-collector-measurements-estimation; solar water heating-Calculation-Types-analysis-economics-Applications; Solar thermal power generation.

Module 2

Direct energy conversion (DEC): DEC devices -Photo voltaic system-Solar cells- Cell efficiency-Limitations-PV modules-Battery back up-System design-Lighting and water pumping applications; Fuel cells. types- losses in fuel cell applications; MHD generators- application of MHD generation.

Module 3

Wind energy: Characteristics-power extraction- types of wind machines .dynamics matching-performance of wind generators .wind mills -applications- economics of wind power - Weibull parameters; WEG technologies for grid connection.

Module 4

Biofuels: **C**lassification-biomass conversion process-applications; ocean thermal energy conversion systems; Tidal and wave power-applications; Micro and mini hydel power;

Hybrid Energy Systems- implementation- case study.

Text book and References :

1. J.N.Twidell & A.D.Weir-Renewable Energy Sources, University press,Cambridge, 2001

2. Sukhatme, S.P., Solar Energy -Principles of Thermal Collection and Storage, Tata McGraw-Hill, New Delhi 1997

3. Kreith, F., and Kreider, J.F., Principles of Solar Engineering, Mc-Graw-Hill Book Co. 2000

4. S.L. Soo, Direct Energy Conversion, Prentice Hall Publication, 1963

5. James Larminie , Andrew Dicks , Fuel Cell Systems, John Weily & Sons Ltd, 2000

6. J. F. Manwell , J. G. McGowan, A. L. Rogers , Wind Energy Explained, John Weily & Sons Ltd 2009

EEP 3203 POWER QUALITY

Course outcomes :

CO1: To understand the effects of various power quality phenomenon in various equipments
CO2 :To familiarize with power quality problems and measurements.
CO3: To study the various issues affecting Power Quality, monitoring, analysis and mitigation methods
CO4 : To know the various power quality enhancement methodologies
CO5 : To understand the various power quality characterizations, sources of issues, their mitigation and monitoring.

Module 1

Introduction-power quality-voltage quality-overview of power quality phenomena-classification of power quality issues-power quality measures and standards-THD-TIF-DIN-C-message weights-flicker factor-transient phenomena-occurrence of power quality problems

Module 2

Harmonics-individual and total harmonic distortion-RMS value of a harmonic waveform-triplex harmonics-important harmonic introducing devices-SMPS-Three phase power converters-arcing devices-saturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads.

Module 3

Power factor improvement- Passive Compensation . Passive Filtering . Harmonic Resonance . Impedance Scan Analysis- Active Power Factor Corrected Single Phase Front End, Control Methods for Single Phase APFC, Three Phase APFC and Control Techniques, PFC Based on Bilateral Single Phase and Three Phase Converter. static var compensators-SVC and STATCOM

Module 4

Active Harmonic Filtering-Shunt Injection Filter for single phase, three-phase three-wire and three-phase four-wire systems. d-q domain control of three phase shunt active filters uninterruptible power supplies-constant voltage transformers- series active power filtering techniques for harmonic cancellation and isolation . Dynamic Voltage Restorers for sag , swell and flicker problems.

Text books and References :

1. G.T. Heydt, Electric power quality, McGraw-Hill Professional, 2007

2. Math H. Bollen, Understanding Power Quality Problems, IEEE Press, 2000

3. J. Arrillaga, .Power System Quality Assessment., John wiley, 2000

4. J. Arrillaga, B.C. Smith, N.R. Watson & A. R.Wood ,.Power system Harmonic Analysis., Wiley, 1997

5. IEEE and IEE Papers from Journals and Conference Records

EEP 3204 A ADVANCED DIGITAL SIGNAL PROCESSING

Course outcomes :

CO1 : Acquire knowledge about the time domain and frequency domain representations as well as analysis of discrete time signals and systems

CO2 : Acquire knowledge about the design of techniques for IIR and FIR filters and their realization structures

CO3 : Acquire knowledge about the finite word length effects in implementation of digital filters.

CO4 : Acquire knowledge about the various linear signal models and estimation of power spectrum of stationary random signals

Module1

Discrete Time Signals, Systems and Their Representations **:**Discrete time signals- Linear shift invariant systems- Stability and causality- Sampling of continuous time signals- Discrete time Fourier transform- Discrete Fourier series- Discrete Fourier transform- Z- transform- Properties of different transforms- Linear convolution using DFT- Computation of DFT

Module 2

Digital Filter Design and Realization Structures: Design of IIR digital filters from analog filters- Impulse invariance method and Bilinear transformation method- FIR filter design using window functions- Comparison of IIR and FIR digital filters- Basic IIR and FIR filter realization structures- Signal flow graph representations

Module 3

Analysis of Finite Word-length Effects Quantization process and errors- Coefficient quantisation effects in IIR and FIR filters- A/D conversion noise- Arithmetic round-off errors- Dynamic range scaling- Overflow oscillations and zero input limit cycles in IIR filters

Module 4

Statistical Signal Processing: Linear Signal Models . All pole, All zero and Pole-zero models .Power spectrum estimation- Spectral analysis of deterministic signals . Estimation of power

spectrum of stationary random signals-Optimum linear filters-Optimum signal estimation-Mean square error estimation-Optimum FIR and IIR filters.

Text books and References

1. Sanjit K Mitra, Digital Signal Processing: A computer-based approach ,Tata Mc Grow-Hill edition .1998

2. Dimitris G .Manolakis, Vinay K. Ingle and Stephen M. Kogon, Statistical and Adaptive Signal Processing, Mc Grow Hill international editions .-2000

3. Alan V . Oppenheim, Ronald W. Schafer, Discrete-Time Signal Processing, Prentice-Hall of India Pvt. Ltd., New Delhi, 1997

4. John G. Proakis, and Dimitris G. Manolakis, Digital Signal Processing(third edition), Prentice-Hall of India Pvt. Ltd, New Delhi, 1997

5. Emmanuel C. Ifeachor, Barrie W. Jervis , Digital Signal Processing-A practical Approach, Addison . Wesley,1993

6. Abraham Peled and Bede Liu, Digital Signal Processing, John Wiley and Sons, 1976

EEP 3204 B SPECIAL ELECTRIC MACHINES & CONTROL

Course outcomes :
CO1 : To evaluate and select a special electric machine drive for particular applications
CO2: To do the basic design of special electrical machine drive systems.

CO3 : To explore the possibilities of special machines in industrial applications

Module 1

Constructional features, principle of operation, modes of excitation, single phase stepping motors, torque production in variable Reluctance (VR) stepping motor, Static torque characteristics- position error due to load torque- performance parameters- resolution, single step response and accuracy- Dynamic characteristics, resonance, pull-in and pull-out characteristics - Closed loop control of stepping motor, microprocessor based controller

Module 2

Switched Reluctance Motors & Synchronous Reluctance Motors: Switched Reluctance Motors -Constructional features, principle of operation. Torque equation, Power controllers, Characteristics and control. Microprocessor based controller. Sensor less control

Synchronous Reluctance Motors-Constructional features: axial and radial air gap Motors. Operating principle, reluctance torque –Phasor diagram, motor characteristics.

Module 3

Permanent Magnet Brushless DC Motors: Introduction Commutation in DC motors, Difference between mechanical and electronic commutators, Hall sensors, Optical sensors,

Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and emf equation, Torques speed characteristics

Module 4

Permanent Magnet Synchronous Motors : Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power controllers, Torque speed characteristics, Self control, Vector control, Current control schemes, sensorless control.

Text books and References

1. R Krishnan, Electric Motor Drives – Modeling, Analysis and Control, PHI, 2003.
2. B K Bose, Modern Power Electronics & AC drives, Pearson, 2002.
3. Kenjo, T and Naganori, S, "Permanent Magnet and brushless DC motors", Clarendon Press, Oxford, 1989.
4. Venkataraman,"Special Electric Machines",OrientBlackSwan/ Universities Press, 2008

EEP 3204 C MODERN COMMUNICATION ENGINEERING

Course outcomes:
CO1: To understand about microwave communication.
CO2 : To get basic knowledge about satellite communication systems.
CO3 : To get knowledge about multiple access techniques, mobile communication and fibre optic communication systems.
CO4 : To understand about basic concepts of radiation and propagation techniques

Module 1
Microwave Communication : Basic principles of microwave links- Microwave Relay Systems – Choice of frequency – line of sight and over the horizon systems – modulation methods – block schematics of terminal transmitters and receivers – microwave repeaters – microwave repeaters – microwave repeaters – microwave antennas – propagation mechanisms – propagation characteristics – path loss models – shadowing models – small scale fading and multipath fading – basic principles of design of microwave link

Module II
Satellite Communication – Orbit of communication satellite – Satellite Constellation – Orbital parameters – Orbital perturbations – Geostationary orbits – Low Earth and Medium Orbits – Look Angles – Frequency selection RF Links – Propagation characteristics – Modulation methods- coding – multiple access – space craft – antennas – transponders – intersatellite link – link power budget – earth station interference – Satellite systems – Geostationary systems – Distress and Safety systems – Navigation systems – direct sound broadcast systems – Direct Television broadcast systems

Module III
Wireless communication systems: Cellular concepts – Cell Splitting and Frequency Reuse - Propagation Mechanisms – Modulation techniques for wireless communication – Analog, Digital and Spread Spectrum modulation – Equalisation, Diversity and Channel coding Diversity

Techniques – Multiple access techniques for Wireless Commuications – FDMA,TDMA and CDMA – Wireless systems and standards – AMPS – Global System for Mobile(GSM) – CDMA – General Packet Radio Service – DECT System .
Fiber optic communication: light wave communication systems- Fiber optic cable - optical transmitter and receiver.

Module 1V
Radiation and Propagation of Waves: - (analysis not required) - Electro magnetic Radiation- Waves in free space- polarization - reception- effects of Environment- Propagation of waves:- Ground waves- Sky-wave propagation - space waves- antennas- Basic consideration - wire radiator in space - common terms and definitions- Effects of ground on Antennas- Directional High frequency Antennas - UHF Micro wave antennas - Wide band and special purpose antennas.

Text books and References

1) Dennis Roddy, John Coolen, 1999 ,*Electronic Communications* , Prentice Hall, India.
2) Kennedy & Davis , *Electronic Communication SystemsFourth Edition-TMH*
3) Frenzel *Communication Electronics* :, *McGraw Hill, International Editions*.
4) Frenzel MGH *Communication Electronics* :

EEP 3204 D MICROCONTROLLER BASED SYSTEM

Course Outcomes:
CO1: To understand the working of advanced microprocessor/controller.
CO2: To learn how to program a processor in assembly language and develop an advanced processor based system.
CO3: To learn configuring and using different peripherals in a digital system.
CO4: To compile and debug a Program.
CO5: To generate an executable file and use it.

Module 1
Basic Computer Organization - Accumulator Based Processors - Architecture - Memory organizations - I/O Organizations - Assembly Language Programming - Addressing - Operations - Stack and Subroutines . Interrupts - DMA - Stages of Microprocessor based Program Development.

Module 2
Introduction to Microcontrollers - Motorola 68HC11 - Intel 8051 - Intel 8096 - Registers - Memories - I/OPorts - Serial Communications - Timers – Interrupts

Module 3
PIC 16F877- Architecture - Elementary Assembly Language Programming - Interrupts – Timers – Memory – I/O ports – SPI – I2C bus - A/D converter - USART- PWM – Interfacing. Introduction to FPGA Devices.

Module 4
Introduction to DSP architecture- computational building blocks - Address generation unit - Program control and sequencing - Speed issues - Harvard Architecture, Parallelism, Pipelining. TMS

320F2407 - Architecture- Addressing modes - I/O functionality, Interrupts, ADC, PWM, Event managers- Elementary Assembly Language Programming - Typical applications

Textbooks and References :

1. John.F.Wakerly: Microcomputer Architecture and Programming, John Wiley and Sons 1981
2. Ramesh S.Gaonker: Microprocessor Architecture, Programming and Applications with the 8085, Penram International Publishing (India), 1994
3. Raj Kamal: The Concepts and Features of Microcontrollers, Wheeler Publishing, 2005
4. Kenneth J. Ayala, The 8051 microcontroller, Cengage Learning, 2004
5. John Morton, The PIC microcontroller: your personal introductory course, Elsevier, 2005
6. Dogan Ibrahim, Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F Series, Elsevier, 2008

EEP 3301 ENERGY MANAGEMENT IN ELECTRICAL SYSTEM

Course outcomes :
CO1: To acquire knowledge about standard methodologies for measuring energy in the workplace and energy audit instruments.
CO2: To acquire knowledge about energy efficient motors, load matching and selection of motors.
CO3: To acquire knowledge about reactive power management, capacitor sizing and degree of compensation.
CO4: Acquire knowledge about cogeneration - types and schemes, optimal operation of cogeneration plants with case studies.

Module 1

System approach and End use approach to efficient use of Electricity: Electricity tariff types; Energy auditing: Types and objectives-audit instruments- ECO assessment and Economic methods-specific energy analysis-Minimum energy paths-consumption models-Case study.

Module 2

Electric motor: Energy efficient controls and starting efficiency-Motor Efficiency and Load Analysis- Energy efficient /high efficient Motors-Case study; Load Matching and selection of motors. Variable speed drives: Pumps and Fans-Efficient Control strategies- Optimal selection and sizing -Optimal operation and Storage; Case study

Module 3

Transformer Loading/Efficiency analysis, Feeder/cable loss evaluation, case study.

Reactive Power management**:** Capacitor Sizing-Degree of Compensation-Capacitor losses-Location-Placement-Maintenance, case study. Peak Demand controls- Methodologies-Types of Industrial loads-Optimal Load scheduling-case study.

Lighting- Energy efficient light sources-Energy conservation in Lighting Schemes- Electronic ballast-Power quality issues-Luminaries, case study.

Module 4

Cogeneration: Types and Schemes-Optimal operation of cogeneration plants-case study; Electric loads of Air conditioning & Refrigeration-Energy conservation measures- Cool storage. Types-Optimal operation-case study; Electric water heating-Gysers-Solar Water Heaters- Power Consumption in Compressors, Energy conservation measures; Electrolytic Process; Computer Controls- software-EMS .

Text books and References

1. Handbook on Energy Audit and Environment Management, Y P Abbi and Shashank Jain, TERI, 2006

2. Handbook of Energy Audits Albert Thumann , William J. Younger , Terry Niehus , 2009

3. Howard E. Jordan, .Energy-Efficient Electric Motors and Their Applications., Plenum Pub Corp; 2nd edition (1994)

4. Albert Thumann , .Handbook of Energy Audits., Fairmont Pr; 5th edition (1998)

5. Albert Thumann, P.W, -.Plant Engineers and Managers Guide to Energy Conservation. - Seventh Edition-TWI Press Inc, Terre Haute, 2007

6. IEEE Recommended Practices for Energy Management in Industrial and Commercial Facilities

7. Energy Efficiency Manual: for everyone who uses energy, pays for utilities, designs and builds, is interested in energy conservation and the environment, Donald R. Wulfinghoff, Energy Institute Press (March 2000)

EEP 3302 SOLAR PHOTOVOLTAIC SYSTEMS

Course Outcomes:

1. To understand the characteristics of solar radiation
2. To understand the operation of PV cell and associated systems
3. To Grasp the basic PV energy schemes
4. To design solar PV system and get idea about its issues

Module 1

Design of solar cells: Solar cell parameters – short circuit current – open circuit voltage- iv and pv characteristics – fill factor – efficiency – Losses in solar cells – model of solar cell – effect of shunt and series resistance, solar radiation and temperature on efficiency –minimization of optical losses and recombination – design for high open circuit voltage – requirements – design for high fill factor – Solar cell characterization using solar simulator and spectral response system.

Module 2

Solar cell technologies: Production of silicon wafer – mono-crystalline and multi-crystalline Silicon ingots – wafer dicing – Solar grade silicon – development of commercial Si solar cells – high efficiency Si solar cells – PESC – buried contact – rear point contact solar cells – organic solar cells – material properties and structure – dye-sensitized solar cell (DSC) – operation – GaAs Solar cells – Thermo photo-voltaics.

Module 3

Solar PV applications: Measurement of solar radiation – optimal angle for fixed collector surface – optimal angle during summer and winter – Solar PV modules – series and parallel connection of cells – mismatch in module series and parallel connection – hot spots – Design and structure of PV modules – number of solar cells in module – fabrication – PV module I-V equation– ratings of PV module – effect of temperature and solar irradiation – batteries for PV system –MPPT– stand alone PV system

Module 4

Solar PV system Design and integration: Solar radiation energy measurements- types of solar PV system- Design methodology for SPV system,Case study on off grid and grid interactive PV system -– design methodology of PV systems – Design of a 1 kW stand alone solar power plant.

Design related issues: grounding, dc arcing, islanding, harmonics, electromagnetic interference, energy yield and economics of a PV installation-

Text books and References

1. Chetan Singh Solanki, Solar Photovoltaics : Fundamentals, Technologies and Applications, PHI Learning Pvt. Ltd., 2011.

2. M. A. Green., Solar Cells: Operating principles, technology and applications, PHI learning ,1982.

3. D. Yogi Goswami, Frank Kreith, Jan F. Kreider, Principles of Solar Engineering, 2nd Edition, Taylor & Francis, 2000, Indian reprint, 2003.

4.Non-conventional Energy Sources, G.D Ray , Khanna Publications

5.Solar Energy, fundamentals and Applications, Garg, Prakash, Tata Mc Graw Hill

EEP 3303 EHVDC & FACTS

Course outcomes :
CO1 : To compare the advantages and disadvantages of EHVAC and EHVDC transmission system.
CO2 : To impart knowledge on operation, modelling and control of HVDC link.
CO3 : To gain deep knowledge in FACTS technology.
CO4 : To develop analytical modeling skills needed for modeling and analysis of UPFC systems with a view towards Control Design.

Module 1
Introduction **:**Need of EHV transmission, standard transmission voltage, comparison of EHV ac & dc transmission systems and their applications & limitations, surface voltage gradients in conductor, distribution of voltage gradients on sub-conductors, mechanical considerations of transmission lines, modern trends in EHV AC and DC transmission

Extra High Voltage Testing: Characteristics and generation of impulse voltage, generation of high Ac and Dc voltages, measurement of high voltage by spheregaps and potential dividers.

Module 2
EHV AC Transmission :
Corona loss formulas, corona current, audible noise – generation and characteristics corona pulses their generation and properties, radio interference (RI) effects, over voltage due to switching, ferroresonance, reduction of switching surges on EHV system
EHV DC Transmission:
Types of dc links, converter station, choice of converter configuration and pulse number, effect of source inductance on operation of converters.
Multi Terminal DC systems (MTDC): Types, control, protection and applications.

Module III
FACTS and preliminaries: FACTS concept and general system considerations - power flow in AC system - definitions on FACTS - basic types of FACTS controllers.
Static Shunt and Series Compensators: Static Shunt Compensators - SVC and STATCOM - Compensator Control - Comparison between SVC and
Static Series Compensation -TCSC and SSSC - operation and control - external system control for series compensators - SSR and its damping

Module IV
Power Quality and introduction to custom power devices: Power Quality issues related to distribution systems – custom power devices – Distribution STATCOM – Dynamic Voltage restorer.
UPFC and IPFC: The Unified Power Flow Controller - operation, comparison with other FACTS devices - control of P and Q - dynamic performance - Special Purpose FACTS Controllers – Interline Power Flow Controller - operation and control.

Text books and Reference :

1. R. D. Begamudre*, "Extra High Voltage AC Transmission Engineering" Wiley Eastern.*
2. K. R. Padiyar, "HVDC Power Transmission Systems: Technology and System Reactions" New Age International.
3. J. Arrillaga," High Voltage Direct current Transmission" IFFE Power Engineering Series 6, Peter Peregrinus Ltd,London.
4. M. S. Naidu & V. Kamaraju, "High Voltage Engineering" Tata Mc Graw Hill.
5. M. H. Rashid , " Power Electronics : Circuits, Devices and Applications" Prentice Hall of India.
6. S. Rao, "EHV AC and HVDC Transmission Engineering and Practice" Khanna Publisher.
7. "EPRI, Transmission Line Reference Book, 345 KV and above" Electric Power Research Institute. Palo Alto,California, 1982.

EEP 3304 A STATISTICAL METHODS FOR ENGINEERING

Course outcomes :
CO1 : To impart knowledge on probability and distributions
CO2 : To acquire basic idea on parametric and non parametric statistical methods
CO3 : To study multivariate analysis, classification of observations, canonical variables

Module 1
Review of Probability and Distributions: Rules for probability,random variables and their distributions, moments, special discrete and continuous distributions, laws of large numbers and central limit theorem, sampling distributions.

Module 2
Parametric Methods: Point estimation – unbiasedness, consistency, UMVUE, sufficiency and completeness, method of moments, maximum likelihood estimation and method of scoring.Bayes, minimax and admissible estimators. Interval estimation - confidence intervals for means, variances and proportions. Testing of Hypotheses - tests for parameters of normal populations and for proportions, goodness of fit test and its applications.

Module 3
Multivariate Analysis: Multivariate normal, Wishart and Hotelling's T 2 distributions and their applications in testing of hypotheses problems. Classification of observations, principal component analysis, canonical correlations and canonical variables.

Module4
Nonparametric Methods: Empirical distribution function, asymptotic distributions of order statistics, single sample problems, problems of location, prediction intervals,KolmogorovSmirnov one sample statistics, sign test, Wilcoxon signed rank statistics, two sample problems, Mann-Whitney-Wilcoxon tests, scale problems,KolmogorovSmirnov two sample criterion, Hoeffding's U-statistics.

Text books and References:
1. An Introduction to Probability and Statistics by V.K. Rohatgi & A.K. Md.E.Saleh.
2. Modern Mathematical Statistics by E.J. Dudewicz & S.N. Mishra
3. Introduction to Probability and Statistics for Engineers and Scientists by S.M. Ross
4. An Introduction to Multivariate Analysis by T. W. Anderson
5. Nonparametric Statistical Inference by J.D. Gibbons & S. Chakraborti

EEP 3304 B PROCESS CONTROL & AUTOMATION

Course outcomes :
CO1: To study the effect of applying advanced control strategies to improve the process control system when working as SISO system and MIMO system

CO2: To get proficiency in multi loop and multi variable Control Systems, effect of process and controller interactions and methods to eliminate these effects.
CO3: To study on advanced process control
CO5: To get knowledge on application of modern control devices in real time systems as case study

Module 1

Process Modeling- Introduction to Process control and process instrumentation-Hierarchies in process control systems-Theoretical models-Transfer function-State space models-Time series models-Development of empirical models from process data-chemical reactor modeling-. Analysis using softwares

Module 2

Feedback & Feedforward Control- Feedback controllers-PID design, tuning, trouble shooting-Cascade control- Selective control loops-Ratio control-Control system design based on Frequency response Analysis-Direct digital design-Feedforward and ratio control-State feedback control-LQR problem- Pole placement -Simulation using softwares-Control system instrumentation-Control valves- Codes and standards- Preparation of P& I Diagrams.

Module 3

Advanced process control-Multi-loop and multivariable control-Process Interactions-Singular value analysis-tuning of multi loop PID control systems-decoupling control-strategies for reducing control loop interactions-Real-time optimization-Simulation using softwares

Module 4

Model predictive control-Batch Process control-Plant-wide control & monitoring- Plant wide control design- Instrumentation for process monitoring-Statistical process control-Introduction to Fuzzy Logic in Process Control-Introduction to OPC-Introduction to environmental issues and sustainable development relating to process industries. Comparison of performance different types of control with examples on software's

Text books and References

1. Seborg, D.E., T.F. Edgar, and D.A. Mellichamp, Process Dynamics and Control, John Wiley , 2004

2. Johnson D Curtis, Instrumentation Technology, (7th Edition) Prentice Hall India, 2002.

3. Bob Connel, Process Instrumentation Applications Manual, McGrawHill, 1996.

4. Edgar, T.F. & D.M. Himmelblau, Optimization of Chemical Processes, McGrawHill Book Co, 1988.

5. Macari Emir Joe and Michael F Saunders, Environmental Quality Innovative Technologies 7 Sustainable Development, American Society of Civil Engineers, 1997.

6. Nisenfeld(Ed) batch Control, Instrument Society of America, 1996.

7. Sherman, R.E. (Ed), Analytical instrumentation, Instrument Society of America, 1996.

8. Shinskey, F.G., Process Conrol Systems: Applications, Design and Tuning (3rd Edition) McGrawHill Book Co, 1988.

9. B. Wayne Bequette , Process control: modeling, design, and simulation *Prentice Hall PTR, 2003*

10. K. Krishnaswamy *, Process Control, New Age International, 2007*

EEP 3304 C DYNAMICS OF ELECTRIC MACHINES

Course outcomes :
CO1 : To develop the basic elements of generalized theory
CO2 : To derive the general equations for voltage and torque of all type of rotating machines
CO3 : To deal with the steady state and transient analysis of rotating machines.

Module 1

BASIC CONCEPTS OF MODELLING

Basic Two-pole Machine representation of Commutator machines, 3-phase synchronous machine with and without damper bars and 3-phase induction machine, Kron's primitive Machine-voltage, current and Torque equations.

DC MACHINE MODELING

Mathematical model of separately excited D.C motor – Steady State analysis-Transient State analysis Sudden application of Inertia Load-Transfer function of Separately excited D.C Motor-Mathematical model of D.C Series motor, Shunt motor.

Module 2

REFERENCE FRAME THEORY

Real time model of a two phase induction machine- Transformation to obtain constant matrices-three phase to two phase transformation-Power equivalence

DYNAMIC MODELING OF THREE PHASE INDUCTION MACHINE

Generalized model in arbitrary reference frame-Electromagnetic torque-Derivation of commonly used Induction machine models- Stator reference frame model-Rotor reference frame model-Synchronously rotating reference frame model-Equations in flux linkages-per unit model.

Module 3

SMALL SIGNAL MODELING OF THREE PHASE INDUCTION MACHINE

Small signal equations of Induction machine-derivation-DQ flux linkage model derivation-control principle of Induction machine.

SYMMETRICAL AND UNSYMMETRICAL 2 PHASE INDUCTION MACHINE

Analysis of symmetrical 2 phase induction machine-voltage and torque equations for unsymmetrical 2 phase induction machine-voltage and torque equations in stationary reference

frame variables for unsymmetrical 2 phase induction machine-analysis of steady state operation of unsymmetrical 2 phase induction machine

Module 4

MODELLING OF SYNCHRONOUS MACHINE

Synchronous machine inductances –voltage equations in the rotor's dq0 reference frame-electromagnetic torque-current in terms of flux linkages-simulation of three phase synchronous machine- Modeling of PM Synchronous motor.

DYNAMIC ANALYSIS OF SYNCHRONOUS MACHINE

Dynamic performance of synchronous machine, three-phase fault, comparison of actual and approximate transient torque characteristics.

Text books and References

1. D.P. Sengupta & J.B. Lynn, Electrical Machine Dynamics, The Macmillan Press Ltd. 1980

2. R Krishnan "Electric Motor Drives, Modeling, Analysis, and Control", Pearson Education., 2001

3. P.C. Kraus, Analysis of Electrical Machines, McGraw Hill Book Company,1987

4. I. Boldia & S.A. Nasar,,Electrical Machine Dynamics, The Macmillan Press Ltd. 1992

5. C.V. Jones, The Unified Theory of Electrical Machines, Butterworth, London1967

6. Generalized Theory of Electrical Machies – P.S.Bimbra – Khanna publications 5th edition-1995

7.. Dynamic simulation of Electric machineryuing Matlab / Simulink - Chee Mun Ong- Prentice Hall

EEP 3304 D RELIABILITY

Course Outcomes:
CO1 : To introduce techniques of evaluation of network reliability /unreliability
CO2 : To model various systems applying reliability networks
CO3 : To evaluate the reliability of simple and complex systems
CO4 : To acquire knowledge on various reliability improvement techniques

Module I

Definition of Reliability: Definition of terms used in reliability, Component reliability, Hazard rate, derivation of the reliability function in terms of the hazard rate. Hazard models – Bath tub curve, Effect of preventive maintenance. Measures of reliability: Mean Time to Failure and Mean Time Between Failures.

Module II:

Evaluation of network Reliability / Unreliability – Series systems, Parallel systems- Series-Parallel systemsPartially redundant systems- Examples. Network Modeling and Evaluation of

Complex systems: Conditional probability methodtie set, Cutset approach- Event tree and reduced event tree methods- Relationships between tie and cutsets- Examples.

Module III:

Network Reliability Evaluation Using Probability Distributions: Reliability Evaluation of Series systems, Parallel systems – Partially redundant systems- determination of reliability measure- MTTF for series and parallel systems – Examples.

Module IV:

Approximate System Reliability Evaluation: Series systems – Parallel systems-
Network reduction techniques- Common mode failures modeling and evaluation techniques- Examples.

Reliability improvements – techniques- use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development – Product life cycles.

Text books and References

- *Roy Billinton and Ronald N Allan, Reliability Evaluation of Engineering Systems, Plenum Press, 1983.*
- *E. Balagurusamy, Reliability Engineering by Tata McGraw-Hill Publishing Company Limited, 2002.*
- *K. K. Agarwal, Reliability Engineering-Kluwer Academic Publishers, 1993*

EEP 3401 POWER ELECTRONIC CONVERTERS FOR DISTRIBUTED ENERGY SYSTEMS

Course Outcomes :
CO1 :To understand technology behind green energy harnessing
CO2 :To understand power electronic application to renewable
CO3 : To undertake projects based on grid interconnected green power system.

Module I

Introduction: Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems.
Electrical machines for Renewable Energy conversion: Review of reference theory fundamentals principle of operation and analysis: IG, PMSG, SCIG and DFIG.

Module II

Solar: Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters- PV energy conversion and multi-level converters, selection of inverter, battery sizing, array sizing. Solar PV pumps, Solar energy storage options. Maximum Power Point Tracking (MPPT).

Module III

Wind: Wind energy conversion, Three phase AC voltage controllers- AC-DC-AC converters, Grid Interactive Inverters - matrix converters.
Hybrid Renewable Energy systems - Need for Hybrid Systems- Analysis of Wind and PV systems.

Module IV

Technological aspects of power electronic systems connection to the grid. Grid connection Issues -Grid integrated PMSG and SCIG Based WECS-Grid Integrated solar system Range and type of Hybrid systems, Case studies of standalone system, Hybrid Energy Systems and its economic evaluation

Text books and References

1. *Rashid .M. H, Power Electronics Handbook, Academic press, 2nd edn., 2001.*
2. Rai. G.D, Non-conventional Energy Sources, Khanna publishers, 1993.
3. Rai. G.D, Solar Energy Utilization, Khanna Publishers, 1993.
4. Gary, L. Johnson, Wind Energy System, Prentice Hall Inc, 1995.
5. B.H. Khan, Non-conventional Energy Resources, Tata McGraw-Hill Publishing Company, New Delhi.

EEP 3402A RESEARCH METHODOLOGY

Course outcomes :
CO1 : To achieve knowledge in various stages of research activity
CO2 : To develop skill in the critical analysis of research articles and reports.
CO3 : To analyze the benefits and drawbacks of different methodologies.
CO4 : To understand how to write a technical paper based on research findings.

Module 1

Introduction; Scientific Method; Research Problem Identification; Research Problem Definition; Research Design; Research Design Process; Decisional Research with Mathematical Models.

Module 2

General Problem Solving; Logical Approach; Soft System Approach; Creative Approach; Group Problem Solving Techniques for Idea Generation; Exploration Problem Identification; Hypothesis Generation; Formulation of the Problem.

Module 3

Research Proposal; Purpose of a Research Proposal; Types of Research Proposals; Development of the Proposals; Requirements of the Sponsoring Agent; Evaluation of Research Proposals; Some Implicit Considerations.

Module 4

Mathematical Models; Development of Models; Solutions of Models; Composite Modelling Methods; Heuristic Optimisation; Heuristic Problem-Solving Approaches; Advantages and Limitations of Heuristic Methods; Simulation Modelling.

Text books and Reference :

1. K.N Krishnaswamy,Appa iyer Sivakumar & M.Mathirajan, Management Research Methodology.Pearson Education.

2. C R Kothari, Research Methodology: Methods and Techniques,New Age International.

EEP 3402B SOFT COMPUTING

Course outcomes :

CO1 : To model any system using soft computing techniques like ANN, Fuzzy and GA. 2. Model any hybrid systems like Neuro Fuzzy for electrical drives control.

CO2 : To learn the basic knowledge regarding activation function, learning rules and various neural networks.

CO3 : To understand the knowledge of crisp set, fuzzy set and Fuzzy logic controllers.

CO4 : To apply the Genetic algorithms in the tuning of controllers

CO5 : To design controllers using Simulation Software fuzzy logic toolbox & NN tool box.

Module 1

Introduction to Neural Network**:** Concept, biological neural network, evolution of artificial neural network, McCulloch-Pitts neuron models, Learning (Supervise & Unsupervise) and activation function, Models of ANN-Feed forward network and feed back network, Learning Rules- Hebbian, Delta, Perceptron Learning and Windrow-Hoff, winner take all.

Module 2

Supervised Learning**:** Perceptron learning,- Single layer/multilayer, linear Separability, Adaline, Madaline, Back propagation network, RBFN. Application of Neural network in forecasting, data compression and image compression.

Unsupervised learning**:** Kohonen SOM (Theory, Architecture, Flow Chart, Training Algorithm) Counter Propagation (Theory , Full Counter Propagation NET and Forward only counter propagation net), ART (Theory, ART1, ART2). Application of Neural networks in pattern and face recognition, intrusion detection, robotic vision.

Module 3

Fuzzy Set: Basic Definition and Terminology, Set-theoretic Operations, Member Function, Formulation and Parameterization, Fuzzy rules and fuzzy Reasoning, Extension Principal and Fuzzy Relations, Fuzzy if-then Rules, Fuzzy Inference Systems. Hybrid system including neuro fuzzy hybrid, neuro genetic hybrid and fuzzy genetic hybrid, fuzzy logic controlled GA. Application of Fuzzy logic in solving engineering problems.

Module 4

Genetic Algorithm: Introduction to GA, Simple Genetic Algorithm, terminology and operators of GA (individual, gene, fitness, population, data structure, encoding, selection, crossover, mutation, convergence criteria). Reasons for working of GA and Schema theorem, GA optimization problems including JSPP (Job shop scheduling problem), TSP (Travelling salesman problem), Network design routing, timetabling problem. GA implementation using MATLAB.

Text Books and References:-

1. S.N. Shivnandam, "Principle of soft computing", Wiley.
2. S. Rajshekaran and G.A.V. Pai, "Neural Network , Fuzzy logic And Genetic Algorithm", PHI.
3. Jack M. Zurada, "Introduction to Artificial Neural Network System" JAico Publication.
4. Simon Haykins, "Neural Network- A Comprehensive Foudation"
5. Timothy J.Ross, "Fuzzy logic with Engineering Applications", McGraw-Hills 1.

EEP 3402C DIGITAL SIMULATION OF POWER ELECTRONIC SYSTEMS

Course outcomes :
CO1 : To model Power Electronic Circuits.
CO2 : To analyze the behaviour of Power Electronic Circuits
CO3 : To provide knowledge on modeling and simulation of power simulation circuits and systems.

Module 1
Review of numerical methods. Application of numerical methods to solve transients in D.C.Switched R, L, R-L, R-C and R-L-C circuits. Extension to AC circuits.
Modeling of diode in simulation. Diode with R, R-L, R-C and R-L-C load with ac supply. Modelling of SCR, TRIAC, IGBT and Power Transistors in simulation. Application of numerical methods to R, L, C circuits with power electronic switches. Simulation of gate/base drive circuits, simulation of snubber circuits.

Module 2
State space modeling and simulation of linear systems. Introduction to electrical machine modeling: induction, DC, and synchronous machines, simulation of basic electric drives, stability aspects.

Module 3
Simulation of single phase and three phase uncontrolled and controlled (SCR) rectifiers, converters with self commutated devices- simulation of power factor correction schemes, Simulation of converter fed dc motor drives ,Simulation of thyristor choppers with voltage, current and load commutation schemes, Simulation of chopper fed dc motor.

Module 4
Simulation of single and three phase inverters with thyristors and self-commutated devices, Space vector representation, pulse-width modulation methods for voltage control, waveform control. Simulation of inverter fed induction motor drives.

Text books and References:

1. Simulink Reference Manua , Math works, USA.
2. Robert Ericson, 'Fundamentals of Power Electronics', Chapman & Hall, 1997.
3. Issa Batarseh, 'Power Electronic Circuits', John Wiley, 2004Simulink Reference Manual, Math works, USA.

EEP 3404D INDUSTRIAL INSTRUMENTATION

Course outcomes :
CO1 : To Select a transducer based on its operating characteristics for the required application.
CO2 : To Check various available techniques available and select appropriate to obtain satisfactory task for the parameter to be measured.
CO3 : To study on calibration of industrial instrumentation
CO4 : To get knowledge on Regulators and power supplies for industrial instrumentation

Module 1

Industrial measurement systems **:** Different types of industrial variables and measurement systems elements – sensors and transducers for different industrial variables like pressure, torque, speed, temperature etc– sensor principles – examples of sensors – sensor scaling – Industrial signal conditioning systems- Amplifiers – Filters – A/D converters for industrial measurements systems –review of general Industrial instruments.

Module 2

Calibration and response of industrial instrumentation : Standard testing methods and procedures – Generalized performance characteristics – static response characterization – dynamic response characterization - zero order system dynamic response characterizations – first order system dynamic response second order system dynamic response – higher order systems - Response to different forcing functions such as step, sinusoidal etc. to zero, first, second third and higher orders of systems.

Module 3

Regulators and power supplies for industrial instrumentation **:** Linear series voltage regulators – linear shunt voltage regulators – integrated circuit voltage regulators – fixed positive and negative voltage regulators – adjustable positive and negative linear voltage regulators – application of linear IC voltage regulators - switching regulators –single ended isolated forward regulators- half and full bridge rectifiers. pH and conductivity sensors. Piezo-electric and ultrasonic sensors and its application in process and biomedical Instrumentation. Measurement of viscosity, humidity and thermal conductivity.

Module 4

Servo drives : Servo drive performance criteria – servomotors shaft sensors and coupling – sensors for servo drives – servo control loop design issues- stepper motor drives types and characteristics – hybrid stepper motor – permanent magnet stepper motor – hybrid and permanent magnet motors – single and multi step responses.

References :

1. Ernest O. Doebelin Measurement systems applications and design, McGraw – Hill International Editions, McGraw- Hill Publishing Company, 1990
2. Patric F. Dunn University of Notre Dame, Measurement and Data Analysis for engineering and science, Mc Graw Hill Higher education, 1995
3. Randy Frank, Understanding Smart Sensors, Artec House Boston. London, 2000
4. Muhamad H Rashid, Power electronics handbook, ACADEMIC PRESS, 2007
5. K Krishnaswamy, Industrial Instrumentation, New Age International Publishers, New Delhi, 2003
6. Gregory K. McMillan, Douglas M. Considine , Process/Industrial Instruments and Controls Handbook,5th Edition, Mc Graw Hill 1999
7. Steve Mackay, Edwin Wright, John Park, Practical Data Communications for Instrumentation and Control, Newness Publications, UK, 2003
8. John O Moody, Paros J Antsaklis, Supervisory Control of discrete event systems using petrinets, PHI, 2002
9. James L Peterson, Petrinet theory and modeling of system, 1981

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EEP 3403A SMART GRID TECHNOLOGIES & APPLICATIONS

Course outcomes :
CO1 : To understand various Smart grid control elements required to monitor and control the grid, such as smart meters, sensors and phasor measurement units.
CO2 : To categorise various Smart grid control elements required to monitor and control the grid
CO3 : To study the smart grid applications within the industry, and design criteria's

Module 1

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.

Module 2

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

Module 3

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)

Module 4

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

References :

1. JanakaEkanayake, KithsiriLiyanage,Jianzhong.Wu, AkihikoYokoyama, Nick Jenkins, "Smart Grid: Technology and Applications"- Wiley
2. Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell
3. Peter S. Fox-Penner, "Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities"
4. James Momoh, "Smart Grid: Fundamentals of Design and Analysis"-Wiley, IEEE Press, 2012.

EEP 3403B HYBRID & ELECTRIC VEHICLE

Course outcomes:

CO1 : To design and develop basic schemes of electric vehicles and hybrid electric vehicles
CO2 : To get knoeledge on proper energy storage systems for vehicle applications
CO3 : To get idea on energy management strategies used in hybrid electric vehicles

Module I

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, , mathematical models to describe vehicle performance. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drivetrain topologies, power flow control in hybrid drive-train topologies

Module II

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives

MODULE III

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. -Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology,

Module IV

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text book and References :

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

EEP3403C SCADA SYSTEMS & APPLICATIONS

Course outcomes:

CO1: To describe the basic tasks of Supervisory Control Systems (SCADA) as wellas their typical applications

CO2: To Acquire knowledge about SCADA architecture, various advantages anddisadvantages of each system

CO3: To Acquire knowledge about SCADA system components: remote terminalunits, PLCs, intelligent electronic devices, HMI systems, SCADA server

CO4: To Acquire knowledge about SCADA communication, various industrialcommunication technologies, open standard communication protocols

CO5: To Learn and understand about SCADA applications in transmission anddistribution sector, industries etc.

Module 1

Introduction to SCADA**:** Data acquisition systems, Evolution of SCADA, Communication technologies,Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries- Consideration and benefits of SCADA system

Module 2

SCADA System Components**:** Schemes- Remote Terminal Unit (RTU),Intelligent Electronic

Devices(IED),Programmable Logic Controller (PLC) - Block diagram, programming languages- Interfacing of PLC with SCADA, Communication Network, SCADA Server, SCADA/HMISystems

Module 3

SCADA Architecture**: V**arious SCADA architectures, advantages and disadvantages of each system - single unified standard architecture -IEC 61850. SCADA Communication**:** various industrialcommunication technologies -wired and wireless methods and fiber optics. open standard communicationprotocols

Module 4

SCADA configuration• Energy management system• System operating states• System security- SCADA Applications**:** Utility applications- Transmission and Distribution sector -operations, monitoring,analysis and improvement. Industries - oil, gas and water. Case studies, Implementation, SimulationExercises

Textbooks and References:

1. Stuart A. Boyer: SCADA-Supervisory Control and Data Acquisition, Instrument Society of America Publications,USA,2004

2. Gordon Clarke, Deon Reynders: Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems, Newnes Publications, Oxford, UK,2004

3. William T. Shaw, Cybersecurity for SCADA systems, PennWell Books, 2006

4. David Bailey, Edwin Wright, Practical SCADA for industry, Newnes, 2003

5. Michael Wiebe, A guide to utility automation: AMR, SCADA, and IT systems for electric power, PennWell 1999

EEP 3403D DIGITAL CONTROL SYSTEM

Course outcomes :

CO1: To acquire knowledge about the modeling of Digital Control Systems

CO2: To acquire knowledge about analysis of digital control systems in the z-domain as well as state space domain

CO3: To acquire knowledge about classical techniques for design of digital controllers with case study examples using MATLAB

CO4: To acquire knowledge about the finite word length effects on system performance.

Module 1

Block diagram of Digital Control System, Advantages & limitations of Digital Control System, comparison of continuous data & discrete data control system, Examples of digital control system. Signal conversion and processing Digital signal coding, data conversion and quantization, sampling period considerations, sampling as impulse modulation, sampled spectra & aliasing, Reconstruction of analog signals, zero order hold, first order hold, frequency domain characteristics, principles of discretization- impulse invariance, finite difference approximation of derivatives, rectangular rules for integration, Bilinear transformation, Mapping between s-plane & z-plane.

Module 2

Representation of digital control system:Linear difference equations, pulse transfer function, input-output model, examples of first order continuous and discrete time systems, Signal flow graph applied to digital control systems.

Module 3

Stability of digital control system in z-domain and Time domain analysis Jury's method, R.H. criteria, Comparison of time response of continuous data and digital control system, steady state analysis of digital control system, Effect of sampling period on transient response characteristics.

Module 4

State space analysis: Discrete time state equations, significance of Eigen values & Eigen vectors, first and secondcompanion form, Diagonalisation, Jordan Canonical form, similarity transformation, state transition matrix, solution of discrete time state equation, Discretization of continuous state space model & its solution. Liyapunov stability analysis, definitions, theorem, concept of equilibrium state.

Pole placement and observer designs: Concept of reachability, Controllability, Constructability & Observability, Design of controller via Pole placement method, state observer design, dead beat controller design, concept of duality.

Text books and References :

1. Digital Contol and State Variable Methods (M. Gopal) Tata McGraw Hill, 2nd Edition, March 2003.
2. Discrete Time Control Systems (K. Ogata) Pearson Education Inc., 1995.
3. Digital Control Systems (B.C. Kuo) Saunders College Publishing, 1992.
4. Digital Control (Richard J. Vaccaro) McGraw Hill Inc., 1995.
5. Modern Control System Design with MATLAB (Ashish Tewari) John Wiley, Feb. 2002.
6. Discrete Time Control Problems using MATLAB (Joe H. Chow, Dean K. Frederick) Thomson Learning, 1st Edition, 2003.
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