ANNA UNIVERSITY: CHENNAI - 25

FACULTY OF ELECTRICAL ENGINEERING

Approved Special Electives for M.S. / Ph.D. Degree Programs
(upto 17th AC 27.04.2012)
### Special Electives for Faculty of Electrical Engineering

<table>
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<tr>
<th>Course Code</th>
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<td>FE1911</td>
<td>DC – DC Converters</td>
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<td>Network System Design Using Network Processors</td>
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<td>Design of Electrical Machines – Electromagnetic Approach</td>
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<td>Modelling and Simulation of DVR and its Controllers</td>
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This course will help to understand how FACTS controllers can be represented in power system simulation programs and how power studies can help to evaluate their applicability and performance characteristics.

INTRODUCTION TO FACTS

FACTS-Concepts and general system considerations, Types of FACTS controllers, Voltage source converters, Self and line commuted current sourced converters, Special purpose FACTS controllers, Generalized and multifunctional FACTS controllers. Types of computer analysis of power systems with FACTS controllers.

SIMULATION AND MODELING OF FACTS CONTROLLERS FOR TRANSIENT STABILITY STUDIES.


SIMULATION AND MODELING OF FACTS CONTROLLERS FOR SMALL SIGNAL STABILITY STUDIES.

Introduction to small signal analysis. Simulation and modeling of FACTS controllers for small signal analysis. Comparison between dynamic and transient stability results.

FACTS CONTROLLERS FOR ELECTRO MAGNETIC TRANSIENTS

Introduction to EMTP. Steady state and time step solutions in EMTP and their uses. Models of synchronous machines. Modeling of FACTS controllers for power system studies using EMTP.

CUSTOM POWER DEVICES


REFERENCES:

EVOLUTIONARY COMPUTING  

UNIT I  GENETIC ALGORITHM  

UNIT II  EVOLUTIONARY COMPUTATION  
The evolution program for numerical optimization, Evolution program versus other methods. An evolution program the GENOCOP system, the GAFOC system.

UNIT III  EVOLUTIONARY STRATEGIES  

UNIT IV  EVOLUTIONARY PROGRAMMING  
Features of Evolutionary programming, Classical Evolutionary programming, Adaptive Evolutionary programming, object oriented analysis, design and implementation. Evolutionary programming. Object oriented testing.

UNIT V  HYBRID EVOLUTIONARY ALGORITHMS  
And Artificial Neural networks, an Evolutionary programming approach to reactive power planning, optimal reactive power dispatch using Evolutionary programming, Application of Neural networks and Evolutionary programming, to short term load forecasting

TEXT BOOK:

REFERENCES:
1. Z. Michalewicz, Genetic algorithms + Data Structures = Evolution Programmes
2. J.A. Momoh, Electric power system applications of optimization
POWER SYSTEM OPTIMISATION

UNIT I  OPTIMAL POWER FLOW  10


UNIT II  LINEAR PROGRAMMING  10


UNIT III  NON-LINEAR PROGRAMMING  10


UNIT IV  INTERIOR POINT METHOD  5


UNIT V  UNIT COMMITMENT & DYNAMIC PROGRAMMING  10

Formulation of unit commitment, modeling in unit commitment, Priority list unit commitment schemes, Different types, unit commitment of Thermal units using dynamic programming. Characteristics of Dynamic programming, Computational economy in Dynamic programming, Illustrative examples.

TEXT BOOKS

1. James A. Momoh, Electric power system applications of Optimization
REFERENCES
2. Hadi Saadat, Power system Analysis, WCB/ Mcgraw Hill, 1999
COORDINATION OF MULTIPLE FACTS DEVICES USING LINEAR / NON-LINEAR CONTROL TECHNIQUE

UNIT I FUZZY LOGIC


UNIT II FUZZY LOGIC IN CONTROL


UNIT III NEURAL NETWORKS IN CONTROL

Neural Network for Non-Linear systems – schemes of Neuro control-system identification forward model and inverse model – indirect learning neural network control applications – Case studies.

UNIT IV MODELING AND CONTROL OF FACTS DEVICES NEURAL AND FUZZY TECHNIQUE


UNIT V STABILITY STUDIES UNDER MULTIPLE FACTS ENVIRONMENT

Introduction to small signal analysis – simulation and modeling of FACTS controllers for small signal analysis. Comparison between dynamic and transient stability results.

Introduction to EMTP – (Electromagnetic Transient programme / Package), Modeling of FACTS controllers for power system studies using EMTP.

REFERENCES:

2. Driankov, Hellendroon, “Introduction to Fuzzy control” Narosa Publisher.

Faulty of Electrical Engineering

(Approved in 8th AC – 18.03.2006) ITEM NO.8.5.7

FE1911 (Old Code PS 1901) DC – DC CONVERTERS L T P C
3 0 0 3

UNIT I INTRODUCTION 9
Historical review – Multiple – Quadrant Choppers – Pump Circuits Development of DC / DC conversion Techniques – Prototypes – DC / DC Converters family.

UNIT II VOLTAGE – LIFE CONVERTERS 9

UNIT III SUPER – LIFT CONVERTERS 9

UNIT IV CASCADED BOOST CONVERTERS 9

UNIT V MULTIPLE QUADRANT OPERATION 9

TOTAL: 45 PERIODS

TEXT BOOK:

REFERENCES:

Faulty of Electrical Engineering  
(Approved in 9th AC – 02.12.2006)  
ITEM NO. FE 9.3

FE1912 NANO ELECTRONICS 3 0 0 3

UNIT I NANOTECHNOLOGY 9

Introduction to Nanotechnology- history & recent trends- Application of Nanotechnology to Electrical engineering- Nanotechnology advantages and various issues.

UNIT II NANO-ELECTRONICS DEVICES: INTRODUCTION 9

Nanoelectronics Devices: Carbon nanotube, FINFET, Quantum transport devices- RTD, Super conducting Digital Electronics, Quantum computing using super conductors- Molecular electronics –Nanoelectronics Memories- nanoelectronics interfacing systems.

UNIT III FABRICATION & DEVICE MODELLING 9


UNIT IV SINGLE ELECTRON TECHNOLOGY 9


UNIT V SIMULATION 9

Simulating single electron devices & circuits- Binary , Multiple valued and mixed mode logics- SET spice modelling- MAT LAB Modelling-SET CMOS Hybrid process.

TOTAL: 45 PERIODS

REFERENCES:

Faulty of Electrical Engineering  
(Approved in 10th AC – 09.06.2007) ITEM NO. FE 10.3(i)

FE1914 APPLICATION OF OPTIMIZATION TECHNIQUES TO POWER SYSTEMS  
L T P C  
3 1 0 4

UNIT I  
INTRODUCTION  
5  
Necessity of optimization in power system, Types of optimization problem, Unconstrained problems, Constrained problems.

UNIT II  
UNCONSTRAINED OPTIMIZATION TECHNIQUES  
10  

UNIT III  
CONSTRAINED OPTIMIZATION TECHNIQUES  
10  

UNIT IV  
INTERIOR POINT METHODS  
10  

UNIT V  
DYNAMIC PROGRAMMING  
10  

L = 45, T = 15. TOTAL = 60

TEXT BOOKS:


REFERENCES:


Faulty of Electrical Engineering (Approved in 10th AC 09.06.2007) ITEM NO. FE 10.3(ii)

FE1915 WIND ELECTRIC CONVERSION SYSTEM L T P C
3 0 0 3

UNIT I THE WIND RESOURCES


UNIT II AERODYNAMICS OF WIND TURBINES


UNIT III WIND TURBINE PERFORMANCE AND DESIGN LOADS FOR WIND TURBINE


UNIT IV CONCEPTUAL DESIGN AND COMPONENT DESIGN OF WIND TURBINE


UNIT V WIND TURBINE CONTROLLER AND HARMONICS

Function of the wind turbine controller – Closed loop control; issues and objective, general techniques, analytical design methods, Pitch actuators control system implementation - Embedded wind generation – Power quality; voltage flicker, harmonics.

TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:

Faulty of Electrical Engineering  (Approved in 10th AC 09.06.2007) ITEM NO. FE 10.3(iii)

FE1916 MODELLING AND SIMULATION OF FACTS DEVICES  L T P C
3 1 0 4

UNIT I INTRODUCTION

UNIT II STATCOM

UNIT III SSSC

UNIT IV MODELLING OF UPFC

UNIT V CONTROL AND IMPLEMENTATION OF UPFC

TOTAL: 60 PERIODS

REFERENCES:

Faulty of Electrical Engineering

ITEM NO. FE 10.3(iv)

FE1917 POWER SYSTEM DEREGULATION

UNIT I INTRODUCTION
Introduction – Deregulation – Different entities in Deregulated Electric markets – Background to deregulation and the current situation around the world – Benefits from competitive electricity market – After – effects of Deregulation – Review of Economic Load dispatch problem (ELD) – Recent development in ELD.

UNIT II MODELING
Optimal power flow (OPF) as a basic tool – OPF model, examples – characteristic features of OPF – Unit commitment (UC) – basic model, additional issues – Formation of power pools – The Energy Brokerage system.

UNIT III STRUCTURE OF DEREGULATED MARKET

UNIT IV CONCEPT OF WHEELING
Power wheeling – Transmission open access – types of transmission services in open access – Cost components in transmission – Pricing of power transactions, and embedded cost based transmission pricing, incremental cost based transmission based transmission pricing – transmission open access and pricing mechanisms in various countries – United kingdom, Chile and Sweden.

UNIT V CONGESTION MANAGEMENT
Developments in international transmission pricing in Europe – security management in deregulated environment, scheduling of spinning reserves, interruptible load options for security management – Congestion management in deregulation, economic instruments for handling congestion.

TOTAL: 45 PERIODS

TEXT BOOK:

REFERENCES:

Faulty of Electrical Engineering (Approved in 10th AC 09.06.2007) ITEM NO. FE 10.3(v)
FE1918 NETWORK SYSTEM DESIGN USING NETWORK PROCESSORS 3 0 0 3

UNIT I REVIEW OF PROTOCOLS AND PACKET FORMATS

UNIT II TRADITIONAL PROTOCOL PROCESSING SYSTEMS

UNIT III NETWORK PROCESSOR TECHNOLOGY

UNIT IV NETWORK PROCESSORS
Overview of Intel Network Processor, Embedded RISC Processor, Packet Processing hardware, Reference System and Software Development Kit.

UNIT V PROGRAMMING MODELS

TOTAL: 45 PERIODS

TEXT BOOK:

REFERENCES:
FE1919  SMART SENSORS: ANALYSIS AND COMPENSATION  3 0 0 3

UNIT I  ANALYSIS OF TRANSDUCERS AND ACTUATORS  (9)
Characteristics and analysis of I and II order Transducers, Study of Electrical, Thermal, Mechanical and Magnetic Transducers and Electromagnetic Actuators.

UNIT II  SENSOR COMPENSATION TECHNIQUES  (9)
Software Techniques, Digital adaptive techniques, Analog adaptive techniques, and Kalman filtering.

UNIT III  FAULT DETECTION AND ISOLATION  (12)
Fault detection and localization using Decorrelation Matrix, Fault reconstruction form sensor and actuator failures, Covariance based Hardware selection, Observer architecture for failure detection and isolation.

UNIT IV  BUSES AND SENSOR NETWORKS  (6)
Smart Transducer Interface Module, Network Capable Application Processor, Transducer Electronic Data Sheet, IEEE 1451 Standards.

UNIT V  ANALOG AND DIGITAL IMPLEMENTATION CASE STUDIES  (9)

TOTAL: 45 PERIODS

TEXT BOOKS:
UNIT I    SYNCHRONOUS NETWORK ALGORITHM
Introduction, Synchronous Network Model, Leader Election in Synchronous ring,
Algorithms in general Synchronous Networks, Distributed Consensus with link failures
Process failure, More Consensus problems.

UNIT II    ASYNCHRONOUS ALGORITHMS
Asynchronous System Model, Asynchronous Shared Memory Model, Mutual
Exclusion, Resource Allocation, Consensus, Atomic Objects.

UNIT III    ASYNCHRONOUS NETWORK ALGORITHMS
Asynchronous Network Model, Basic Asynchronous Network Algorithms,
Synchronizers, Shared Memory Vs Networks, Logical time.

UNIT IV    RESOURCE ALLOCATION AND FAILURES
Global Snapshots and stable Properties, Network Resource Allocation, Asynchronous
Networks with Process Failures, Data Link Protocols.

UNIT V    PARTIALLY SYNCHRONOUS ALGORITHMS
Partially Synchronous System Models, Mutual Exclusion with Partial Synchrony,
Consensus with Partial Synchrony.

TEXT BOOK:

REFERENCES:
Computing” CRC Press.
Faulty of Electrical Engineering (Approved in 10th AC 09.06.2007) **ITEM NO. FE 10.3(viii)**

**FE 1921 SUPPORT VECTOR MACHINE 3 0 0 3**

**UNIT I LEARNING AND SOFT COMPUTING**

**UNIT II GENERALIZATION AND OPTIMIZATION THEORY**

**UNIT III SUPPORT VECTOR MACHINE**

**UNIT IV KERNEL INDUCED FEATURE SPACE**
Learning in Feature Space – The Imlicit Mapping into Feature Space – Making Kernels Kernels and Gaussian Processes – PCA.

**UNIT V APPLICATION OF SVM**

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**
1. Nello Cristianini and John Shave – Taylor, An introduction to support vector machines and other kernel based learning methods, Springer.

**REFERENCES:**
1. T.Hastie, R.Tibshirani, Friedman, The Elements of Statistical Learning, Springer.

Faulty of Electrical Engineering  
(Approved in 10th AC 09.06.2007) ITEM NO. FE 10.3(ix)

FE 1922 INTERVAL SYSTEM ANALYSIS 3 0 0 3

UNIT I
Basic properties of interval arithmetic: Motivation: Intervals: Rounded interval arithmetic
interval vectors and arithmetic expressions: Algebraic properties of interval: operations:
Rules of Mid-point, radius and absolute value: distance and topology.

UNIT II
Enclosures for the range of function : Analysis of interval evaluation: inclusions algebras
and recursive differentiation: The mean value form and other centered forms:
interpolation forms.

UNIT III
Matrices and sub linear mappings: Basic facts: Norms and spectral radius: Distance and
topology : Linear interval equations: sub linear mappings: M-Matrices and inverse
positive matrices: H-Matrices.

UNIT IV
The solution of square linear systems of equations preconditioning: Krawezk’s Method
and quadratic approximation: interval Gauss – Siedal interation: Linear fixed point
equations: interval Gauss elimination.

UNIT V
Nonlinear systems of equations Existence and uniqueness: Interval interation: Set-Velued functions: Zeros of continuous functions: Local analysis of parameter dependent
nonlinear systems: Global Problems Hull Computations.

TOTAL: 45 PERIODS

REFERENCES:
FE1923 LOSS ALLOCATION IN A DEREGULATED POWER SYSTEM 3 0 0 3

UNIT I INTRODUCTION TO DEREGULATED POWER SYSTEM 8


UNIT II BILATERAL TRANSACTION 8


UNIT III TRANSMISSION LOSS ALLOCATION & ECONOMIC POWER SYSTEM OPERATION 12


UNIT IV LOSS ALLOCATION IN BILATERAL MARKET 7


UNIT V LOSS ALLOCATION IN A COMBINED POWER POOL AND BILATERAL MARKET USING ANN 10


TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:
FE1924 INTRODUCTION TO NONLINEAR SYSTEMS 3 0 0 3

UNIT I INTRODUCTION TO NONLINEAR CONTROL 9
Nonlinear systems, Examples of nonlinear dynamics, Simple examples of nonlinear control, Basic notions of Euclidean and topological spaces, Illustrative examples.

UNIT II STABILITY OF NONLINEAR SYSTEMS 9

UNIT III DIFFERENTIABLE MANIFOLDS – LOCAL THEORY 9
Differentiability Classes, Tangent Vectors, Smooth Maps and Their Differentials – Diffeomorphisms, Applications in Control.

UNIT IV INTRODUCTION TO FEEDBACK LINEARIZATION 9
Smooth Vector Fields, Input – Output Linearization, Relative Degree Normal Form Zero Dynamics, Control examples.

UNIT V CONTROLLABILITY OF NONLINEAR SYSTEMS 9
Definition of a distribution, Lie brackets, Involutive distributions, Accessibility Applications in Control.

TOTAL: 45 PERIODS

REFERENCES:
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<td><strong>SOA FUNDAMENTALS</strong></td>
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<td>Entities – characteristics – development – life cycle and design –</td>
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<td><strong>WEB SERVICES</strong></td>
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<td>Introduction – Web Services Implementation – Development – Benefits</td>
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<td><strong>STANDARDS AND DIFFERENT MODELS</strong></td>
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<td>processing models – describing web services – functional</td>
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<td>characteristics – developing web services – registries.</td>
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<td><strong>JAVA IMPLEMENTATION STANDARDS AND TOOLS</strong></td>
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<td>Java Based distributed applications - JAXB – JAXRPC – JAXR – JAXM</td>
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<td>– other distributed models (composition with web services ) – RPC</td>
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<td>– CORBA – RMI – DCOM etc.</td>
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<td><strong>APPLICATIONS AND PRACTICAL CONSIDERATIONS</strong></td>
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<td>Security – performance – transaction management – web services</td>
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<td>management – interoperability and WSI – dynamic web services –</td>
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<td>scalability and other standard BPEL.</td>
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**TOTAL:** *45 PERIODS*

**REFERENCES:**

UNIT I INTRODUCTION TO BIOMECHANICS

Introduction to mechanics in medicine - stress, shear and strain, principal stresses and transformations, loading modes, shear rate, Newtonian and non-Newtonian laws - viscosity, viscoelasticity - biosolid and biofluid mechanics, composition and microstructure of blood vessels, mechanical properties of soft tissues.

UNIT II MATHEMATICAL MODELS IN BIOMECHANICS

Constitutive models and development of constitutive equations; pseudo elastic, randomly elastic, poroelastic and viscoelastic models, representation of the pseudo elastic stress – strain relationship, numerical models in biomechanics - generalized stochastic models.

UNIT III COMPUTATIONAL METHODS IN BIOMECHANICS

Models of structure and deformations, single layer and multi layer models, strain energy function - image based morphological modeling - measurement based physiological modeling - patient specific computational mechanical modeling.

UNIT IV INSTRUMENTATION IN BIOMECHANICS

Ultrasound imaging technique in biomechanics; instrument design, application in blood vessel structure and functions - MRI in biomechanics, 3D visualization - instrumentation in cardiovascular biomechanics.

UNIT V Experimental Biomechanics


TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:
UNIT I


UNIT II


UNIT III


UNIT IV

Methods for implementing model predictive control Model predictive control and multiparametric programming – implementation of model predictive control for uncertain systems – closed loop min-max model predictive control implementation of model predictive control and dead time consideration.

UNIT V

Case Study Model predictive control on a chip – FPGA implementation of MPC – FPGA implementation of MPC for a petrochemical process.

TOTAL: 45 PERIODS

REFERENCES:

FE1928  REINFORCEMENT LEARNING  3 0 0 3

UNIT I  Reinforcement Learning Introduction and Learning Problem
Introduction, elements of reinforcement learning, history, evaluative feedback, Rewards and returns, Markov Decision Processes, Value functions, optimality and approximation

UNIT II  Dynamic Programming
Value iteration, policy iteration, asynchronous DP, generalized policy iteration, Monte-Carlo methods: policy evaluation, roll outs, on policy and off policy learning, importance sampling

UNIT III  Temporal Difference learning
TD prediction, Optimality of TD(0), SARSA, Q-learning, R-learning, Games and after states Eligibility traces: n-step TD prediction, TD(lambda), forward and backward views, Q(lambda), SARSA(lambda), replacing traces and accumulating traces.

UNIT IV  Function Approximation
Value prediction, gradient descent methods, linear function approximation, ANN based function approximation, lazy learning, instability issues
Policy Gradient methods: non-associative learning - reinforce algorithm, exact gradient methods, estimating gradients, approximate policy gradient algorithms, actor-critic methods

UNIT V  Planning and Learning
Model based learning and planning, prioritized sweeping, heuristic search, trajectory sampling. Case studies: Elevator dispatching, Samuel's checker player, TD-gammon, Acrobot

TOTAL: 45 PERIODS

REFERENCES:
FE1929 MODELLING AND SIMULATION OF WIND ENERGY CONVERSION SYSTEMS

UNIT I : Introduction
Components of WECS – Major WECS schemes – Power obtained from wind – simple momentum theory – Sabinin’s theory – with velocity components at blade element.

UNIT II : Wind turbines

UNIT III : Special Machines for WECS

UNIT IV : Modelling of PMSG
Traditional dq0 model – Embedded phase domain model for real time simulation – Model including magnetic saturation – Dynamic model including losses.

UNIT V : Grid Interconnection
Grid Interconnection Issues – Cost benefits – Grid side controllers – WECS in various countries – Simulation of PMSG based WEC.

REFERENCES
UNIT – Introduction


UNIT – II Methods of Field Computation


UNIT – III Thermal analysis of Electrical Machines


UNIT – IV FEA of Synchronous Machine


UNIT – V Modeling of Machines


REFERENCES:
FE 1931 APPLICATION OF INTELLIGENT CONTROLLERS
FOR POWER QUALITY IMPROVEMENT

1. INTRODUCTION

2. INTRODUCTION TO CUSTOM POWER DEVICES
DSTATCOM Structure, DSTATCOM in Voltage control mode: State/ Output feed back control. DVR Structure: State/ Output Feed back Control. UPQC – Structure and Control of Right - Shunt /Left - Shunt UPQC.

3. SOLID STATE LIMITING, BREAKING AND TRANSFERRING DEVICES

4. MODELLING AND SIMULATION TECHNIQUES FOR HARMONIC FILTERS

5. NEURO-FUZZY CONTROLLER FOR STATCOM

TOTAL = 45 PERIODS

TEXT BOOKS:

REFERENCES
FE 1932  FAULT DIAGNOSIS IN ELECTRICAL MACHINES  3 0 0 3

UNIT I
Technology trends in fault diagnosis of Electrical Machines - a) Transformers  b) Electrical machines - State Estimation methods for Electrical Machines modeling Simulation studies of transients in Electrical Machines (PSPICE, MATLAB).

UNIT II
Occurrence of faults in transformer and machines due to aging - Types of faults in transformer – insulation breakdown-winding breakdown - Types of faults in Machines – insulation, winding and mechanical breakdown.

UNIT III
Condition monitoring of Electrical machines - Acoustic monitoring of Core - Vibrations in Transformers and Bearing Noise in Machines - Study of faults in Inverter-fed Machines.

UNIT IV
Fourier transform and Wavelet Transforms for fault diagnosis - Model based prediction theory applied to fault detection in Electrical Machines - Discrete Event Systems approach for fault detection - Markov models for Fault diagnosis.

UNIT V
Behavior-Modulation Techniques for fault detection - Pattern Recognition applied to fault detection - Application of Artificial Intelligence tools like Fuzzy Logic, Neural Networks for fault diagnosis in Electrical Machines.

REFERENCES:

TOTAL = 45
FE 1933 OPTIMIZATION TECHNIQUES FOR POWER SYSTEM RESTORATION 3 0 0 3

1. INTRODUCTION 06

Necessity of optimization in power system, Types of optimization problem, Unconstrained problems, Constrained problems.

2. UNCONSTRAINED OPTIMIZATION TECHNIQUES 10


3. CONSTRAINED OPTIMIZATION TECHNIQUES 10


4. NON LINEAR AND DYNAMIC PROGRAMMING 10


5. CASE STUDY 09

Application of optimization techniques to power system restoration
C.P.M and P.E.R.T for Project scheduling

TOTAL = 45 PERIODS

TEXT BOOKS

REFERENCES
UNIT I  INTRODUCTION

Introduction to power quality – Over view of power quality phenomena – voltage sags – Characterization, Equipment behavior – Mitigation of voltage sags.

UNIT II  ANALYSIS OF INVERTER


UNIT III  DYNAMIC VOLTAGE RESTORER


UNIT IV  DVR CONTROLLERS


UNIT V  APPLICATIONS OF DVR

Mitigation of voltage sags – Mitigation of voltage swells – Reduction of voltage harmonics – Minimum active power injection – Simulations with commercial software packages.

REFERENCES:

FE1935 MODERN RECTIFIERS AND RESONANT CONVERTERS  L T P C
                    3 0 0 3

UNIT I  POWER HARMONICS & LINE COMMUTATED RECTIFIERS  9

Average power RMS value of a waveform – Power factor-AC line current harmonic standards IEC 1000-IEEE 519. The Single phase full wave rectifier-Continuous Conduction Mode-Discontinuous Conduction Mode-Behaviour when C is large-Minimizing THD when C is small. Three phase rectifiers – Continuous Conduction Mode-Discontinuous Conduction Mode- Harmonic trap filters.

UNIT II  PULSE WIDTH MODULATED RECTIFIERS  9


UNIT III  RESONANT CONVERTERS  9


UNIT IV  DYNAMIC ANALYSIS OF SWITCHING CONVERTERS  9

Review of linear system analysis-State Space Averaging-Basic State Space Average Model – State Space Averaged model for an ideal Buck Converter, ideal Boost Converter, ideal Buck Boost Converter, for an ideal Cuk Converter.

UNIT V  CONTROL OF RESONANT CONVERTERS  9

Pulse Width Modulation – Voltage Mode PWM Scheme- Current Mode PWM Scheme – Design of Controllers: PI Controller, Variable Structure Controller, Optional Controller for the source current shaping of PWM rectifiers.

TOTAL: 45 PERIODS

REFERENCES:
2. William Shepherd and Li zhang “ Power Converters Circuits” Marceled Ekkerin,C.
3. Simon Ang and Alejandro Oliva “Power Switching Converters” Taylor & Francis group
UNIT I  DC-DC CONVERTERS AND SMPS


UNIT II  CONTROL TECHNIQUES

Industrial PWM driver chips for power supplies such as UC3843,3825 or equivalent-voltage mode control – current mode control- one step control – SMC controller.

UNIT III  EMI IN POWER ELECTRONIC EQUIPMENT

EMI from power semiconductors – EMI from controlled Rectifier circuits – EMI calculation for semiconductor Equipments – Predicting EMI from a power supply with Rectifiers – EMI Prediction and design of filters- EMI Prediction for switching power supplies.

UNIT IV  SPREAD SPECTRUM TECHNIQUE


UNIT V  APPLICATION

Application of frequency hop spread spectrum technique into Buck converter through simulation.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Simon.S.Ang, Alexandro Oliver , “Power-Switching converters”, Taylor and Francis

REFERENCES:

FE1937 MODELLING AND CONTROL OF HYBRID SYSTEMS  L T P C
3 0 0 3

UNIT I HYBRID SYSTEMS AND THEIR REPRESENTATION  9
Hybrid dynamical system structure – Hybrid Phenomena – Classification of Hybrid System models – Hybrid automata – Example of Hybrid systems: Thermostat control, Water level control, Two tank system.

UNIT II MODELING OF HYBRID SYSTEMS (Conventional approach)  9

UNIT III MODELLING USING PETRINETETS  9

UNIT IV TOOLS FOR MODELLING HYBRID SYSTEMS  12

UNIT V CONTROL OF HYBRID SYSTEMS  6

TOTAL: 45 PERIODS

TEXT BOOKS:
3. “Modelling and control of Hybrid systems” Lecture notes
FE1938 DESIGN AND CONTROL OF SWITCHED RELUCTANCE MACHINE FOR AUTOMOTIVE APPLICATIONS

UNIT I DESIGN OF SWITCHED RELUCTANCE MACHINE


UNIT II CONVERTERS FOR SWITCHED RELUCTANCE MACHINE DRIVES

Converter configurations – asymmetric bridge converter – single switch per phase converter – (q+1) switch and diode configurations – C-dump converter – design procedure – two – stage power converter.

UNIT III CONTROL OF SWITCHED RELUCTANCE MACHINE DRIVES


UNIT IV FEA OF SWITCHED RELUCTANCE MACHINE MOTORS


UNIT V NOISE AND VIBRATION OF SWITCHED RELUCTANCE MACHINE


TOTAL: 45 PERIODS

TEXT BOOKS:


FE1939 ANALYSIS, DESIGN AND CONTROL OF STEPPING MOTORS 3003

UNIT I INTRODUCTION


UNIT II THEORY OF ELECTROMAGNETICS & DYNAMIC CHARACTERISTICS


UNIT III OPEN LOOP & CLOSED LOOP CONTROLLER OF STEPPING MOTOR

Drive system – Logic sequencers – Motor driver – Input controller – Acceleration and deceleration by a Microprocessor Limitations of open-loop operation and need for closed loop operation – The concept of lead angle – A closed-loop operation system using a microprocessor – Direct-drive servomotor - Development of integrated circuits for closed-loop operation – Switched reluctance drive – Use of current waveforms as a position sensor.

UNIT IV CONVERTERS

Control of Stepping motor using Converter, Inverter, Chopper - Implementation of PWM techniques

UNIT V CASE STUDY

Application of stepping motors in Robotics

TOTAL: 45 PERIODS

REFERENCES:


2. IEEE papers
FE1940 PRINCIPLES, DESIGN AND FABRICATION OF MEMS DEVICES 3003

UNIT I  FUNDAMENTALS OF MEMS DEVICES 9
Scaling of MEMS devices – Scaling of Mechanical systems - MEMS architecture -
Electromagnetic and its application for MEMS devices – Classical mechanics and its
application – Newtonian mechanics – Lagrange equations of motions – Hamilton
equations of motion – Atomic structures and quantum mechanics – Thermo analysis and
heat equation.

UNIT II  BIO-MEMS: SENSORS AND ACTUATORS 9
Scaling in micro fluidics - Flow physics – Liquid flows in micro channels – Micro fluidic
simulation models – Physics of thin liquid films – Biomems materials - Bio-sensors –
Micro valves

UNIT III  PRESSURE, VIBRATION AND TEMPERATURE SENSORS 9
Piezo resistive pressure Sensor – Capacitive Pressure sensor - Accelerometer -
Magnetic sensors – Micro actuators – Electro static – Electro magnetic – Thermal-Piezo
electric.

UNIT IV  DESIGN, FABRICATION AND PACKAGING OF MEMS DEVICES 9
Fabrication of cantilever beams- Modeling of micro-electro mechanical systems - Micro
pump applications in BIOMEMS – Packaging

UNIT V  BIO-MEMS APPLICATIONS 9
Lab on a chip based on BIO-MEMS - System on a chip model of a micro pump – MEMS
piezoresistive pressure sensor for biomedical applications - MEMS viscometric sensor
for continuous glucose monitoring.

REFERENCES:

   Sensors”, Artech House Publishers, 2004
3. Tai-Ran Hsu, “MEMS & Microsystem Design & Manufacture”, McGraw-Hill, Boston,
   2002
   Press, 2007
5. Sergey Edward Lyshevski, “Nano- And Microelectromechanical Systems” CRC
   Press, 2001
6. Julian W. GardnerVijay, K. Varadan, Osama, Awadelkarim “Microsensors, MEMS,

TOTAL:45 PERIODS
FE1941 ANALYSIS AND CONTROL OF SPECIAL MACHINES 3003

UNIT I SWITCHED RELUCTANCE MOTOR (9)

UNIT II CONVERTERS (9)
Converters for SRM drives – Asymmetric bridge converters – Single switch per phase – Two phase power converters- Resonant converter circuits.

UNIT III CONTROL STRATEG (9)
Control of SRM drive – Closed loop speed controlled SRM – Design of current controller flux linkage controller Torque control and speed control – Modeling of SRM noise control in SRM

UNIT IV STEPPER MOTORS (9)

UNIT V DRIVE SYSTEM (9)
Drive system and circuitry for open loop control system – Driver system – Logic sequence motor drive input controller – Closed loop control of stepping motor – Concept of lead angle – Closed loop operation system – Direct drive servo motor – Switched reluctance drive.

TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES :
FE1942 INTELLIGENT CONTROL APPLICATIONS TO BLDC MOTORS

UNIT I GENETIC ALGORITHM

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm.

UNIT II ARTIFICIAL NEURAL NETWORKS

Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madaline, Feed-forward Multilayer Perceptron. Learning and Training the neural network. Hopfield network, Self-organizing network and Recurrent network. Neural Network based controller.

UNIT III FUZZY LOGIC SYSTEM

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control. Stability analysis of fuzzy control systems.

UNIT IV PERMANENT MAGNET BRUSHLESS DC MOTORS

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, Torque-speed characteristics - Mathematical Model Controller design.

UNIT V APPLICATIONS TO MOTION CONTROL

GA application to motor control optimisation problem, Identification and control of linear and nonlinear dynamic systems using Neural Network. Implementation of fuzzy logic controller for DC motor speed control.

TOTAL: 45 PERIODS

REFERENCES:

UNIT I  HVDC OPTIONS
Developments in line commutated High Voltage Direct Current Schemes (HVDC) schemes – STATic COMpensator (STATCOM) aided DC transmission – comparison of Line Commutated Converter (LCC) link and Voltage Source Converter (VSC) link – frequency cross modulation across LCC.

UNIT II  TOPOLOGIES FOR DC TRANSMISSION

UNIT III  VSC HVDC FOR WIND POWER EVACAUTION

UNIT IV  HYBRID SCHEMES
Basic Current Source Converter (CSC) operation – modulated tripole DC transmission – hybrid VSC and CSC transmission – hybrid VSC and LSC transmission – power transfer characteristics – current relationships – harmonics – comparison of various multilevel topologies.

UNIT V  MODELLING AND SIMULATION

TOTAL: 45 PERIODS

REFERENCES:
1. THE CALCULUS OF VARIATIONS


2. DYNAMIC PROGRAMMING


3. THE MINIMUM (MAXIMUM) PRINCIPLE


4. OPTIMAL CONTROL SYSTEM DESIGN

LQR design method, kalman filter technique, LQG design method. Robust optimal control system design using loop transfer recovery technique. Implementation of optimal controller and its related issues.

5. ON-LINE OPTIMIZATION AND CONTROL

Model based predictive controllers, MPC elements-prediction model, objective function, control law. DMC, algorithmic control, predictive functional control, generalized predictive control. Simple implementation of GPC for industrial process.

TOTAL : 45 PERIODS

REFERENCES :

FE9002 INSULATION CO-ORDINATION OF GAS INSULATED SYSTEMS 3003

1. SOURCES OF VERY FAST TRANSIENT OVERVOLTAGES 9

Type of over voltage stresses imposed on Gas Insulated substations (GIS) - Temporary over voltages, lightning over voltages, switching over voltages - Principle of over voltage propagation in GIS - Origin and severity of over voltages entering the GIS.

2. GAS INSULATED SUBSTATIONS 9


3. FACTORS AFFECTING INSULATION STRENGTH AND ON-SITE TESTING 9


4. EFFECT OF VFTO ON POWER APPARATUS 9

Withstand strength of GIS and on switchgear, transformers, surge arresters - Influence of substation and line parameters - interaction between line parameters on over voltages stressing GIS insulation – Equipment insulation - Different means to limit the over voltages.

5. INSULATION CO-ORDINATION 9

Insulation Co-ordination of GIS using Surge Arresters - Selection and location - Conventional method based on specified Incoming over voltages - Probabilistic Method - Economical aspects of insulation level.

TOTAL : 45 PERIODS

REFERENCES:

FE 9003 STATISTICAL TECHNIQUES FOR HIGH VOLTAGE ENGINEERING 3 0 0 3

1. REVIEW OF FUNDAMENTALS 9


2. STOCHASTIC NATURE OF BREAKDOWN 9

Statistical features of breakdown - Weibull Distribution and other statistical distributions - Effect of voltage and time on the failure statistics

3. STOCHASTIC MODELS OF BREAKDOWN 9

Statistical and physical connections - Fluctuation model - Fractal description of breakdown - Cumulative defect models of breakdown - Differences and similarities in model statistics

4. TEST METHODS 9

Distribution Tests - Graphical Methods, Mathematical methods - F test - Double-t test - U test - Test of independence of realizations - laboratory tests - constant stress test, progressive test tests, effect of voltage on lifetime

5. STATISTICAL DESCRIPTION OF INSULATION CAPACITY 9

Choice of Variate - Air, Compressed-gas, Liquid and Solid insulation - uniform and Non Uniform insulation - Statistics of partial discharges

TOTAL: 45 PERIODS

REFERENCES:


GREEN ENGINEERING: CHOICE OF LIGHTING TECHNOLOGIES


TRANSITION TO SOLID STATE LIGHTING


RETROFIT ECONOMICS


LUMINAIRE FIXTURE


LIGHT FITTINGS

Focusing Lours for flood lighting- Shielding angle- Cut-off angle- Barn doors- colour filters- Light Distribution- Symmetric- and Asymmetric- Diffused and Focussed- Direct and Indirect Beam spread classification- Batwing light distribution

REFERENCES:

1. Craig Delouse- “The Lighting Management Hand Book”- The FAIRMONT PRESS.

TOTAL: 45 PERIODS
FE 9005 ROBUST CONTROL AND SLIDING MODE CONTROL

1. INTRODUCTION TO ROBUST CONTROL AND H- NORM


2. PARAMETRIZATION AND ROBUST STABILIZATION


3. H2 AND H- OPTIMIZATION


4. INTRODUCTION TO SMC, PASSIVITY AND FLATNESS

Dynamics in the sliding mode – linear system, non-linear system, chattering phenomenon – sliding mode control design – reachability condition, robustness properties – application to boost dc-dc converters- flatness, passivity properties through flatness, non – minimum phase output stabilization, trajectory planning.

5. STABILITY AND STABILIZATION


REFERENCES:


TOTAL: 45 PERIODS
FE9006  FOOD PRESERVATION TECHNIQUES  3003

1. DRYING & THERMAL PROCESSING  
Recent developments in drying including spray drying, freeze drying, foam mat drying and other newer drying processes; newer methods of concentration and evaporation; freeze concentration design aspects; membrane filtration for recovery of low concentration products; applications of ultra-filtration and reverse osmosis. Use of electric current for thermal processing of foods; relationship of conductance and heating of foods; Ohmic heating: principle & applications.

2. NON-THERMAL METHODS  
Chemical preservatives - Food additives, functional chemical additives applications. Chemical preservatives and antibiotics; Preservation by ionizing radiations- technology aspects of the radiations, pasteurization of foods; public health aspects, microbiology of irradiated foods; Ultrasonics, high pressure, fermentation, curing, pickling, smoking, membrane technology. Hurdle technology.

3. RADIATION PROCESSING  
Generation of irradiation by different techniques including gamma rays and electron acceleration; Safety and effect of radiation doses; Radiation processing of cereals & grains, meat, fish & poultry products, spices & herbs etc. Control of ripening of fruits by irradiation; Infra-red heating: interaction of infra-red (IR) radiation with penetration properties, equipment; dairy and food application, advantages and disadvantages of IR heating.

4. PULSED ELECTRIC FIELDS  
Introduction-definitions, descriptions and applications-mechanisms of microbial inactivations-electrical breakdown-electroporation-inactivation models -Critical factors-analysis of process, product and microbial factors-pulse generators and treatment chamber design-Research needs.

5. APPLICATION OF PEF TECHNOLOGY IN FOOD PRESERVATION  
Processing of juices, milk, egg, meat and fish products- Processing of water and waste. Industrial feasibility, cost and efficiency analysis.

TOTAL: 45 PERIODS

TEXT BOOKS

REFERENCES:
FE9007 WEB BASED EMBEDDED SYSTEMS 3003

1. EMBEDDED SYSTEMS

Embedded System – Hardware Architecture - Software Components —
Communications - Embedded Development Environment – Embedded Computing
Platform – Distributed Embedded System Design - Embedded Design Techniques

2. EMBEDDED NETWORKING

Introduction – Principles of Networking, Networking for Embedded systems – Network
Technology Standard ,Protocols -TCP/IP, Architecture Implementation, Embedding
TCP/IP – Embedded Networking with Java - Networking software for Embedded
Systems, CAN networks.

3. ROUTING METHODOLOGIES

Introduction – Hubs, Bridges, Routers, Routing protocols, Routing Security, Switch
based routing , unicast, multicast routing, embedded routing - Routing components,
Routing levels, routing protocols Web based routing - Routing components, protocols,
Types of routing.

4. WEB BASED CLIENT- SERVER COMMUNICATION

Introduction – A client-Sever approach, Methods of communication , Components –
HTTP protocol, web browsers, web servers, Languages - HTML and its extension, Java
applets - Interaction with server using CGI and alternatives – server side programming
and control – Design of web pages using client-side scripting-Web security

5. CASE STUDIES

Web-based Embedded Computing - Design of a web based monitor system for
embedded applications – Web based control applications.

TOTAL : 45 PERIODS

REFERENCES:
1. William Stallings"High speed Networks TCP/IP and ATM Design Principles”
   York, 1995
3. Designing embedded Internet devices by Dan Eisen Reich, Brian DeMuth
4. Embedded networking with CAN and CAN open by Copperhill Technologies
   Corporation' Olay Pfeiffer, Andrew Ayre, Christian Keydel
5. A methodology for client/server and web application development by Roger Fournier
6. The Internet directory by Eric Eugene Braun.
FE9008 ADVANCED PID CONTROL 3 0 0 3

1. INTRODUCTION 9
Feedback fundamentals, PID controller-Two degree freedom controller- Issues related to implementation- integral windup. Stability, sensitivity functions, robustness to process variations, requirements and specifications.

2. PID STABILIZATION 9
PI, PID stabilization – characterization and computation.

3. PID CONTROLLER DESIGN 9
ZN & related methods, rule based empirical tuning, pole placement, lambda tuning, algebraic design, optimization methods, robust loop shaping, and frequency response methods. IMC based PID tuning. Design for disturbance rejection.

4. ROBUST PERFORMANCE AND PERFORMANCE ASSESSMENT 9

5. ADAPTIVE PID CONTROL 9
Autotuning, Adaptive Technique-model based methods-rule based methods, Multimodel based PID Controller design, nonlinear PID Controller design.

TOTAL : 45 PERIODS

REFERENCES:
**FE9009**  |  **CONTROL OF POWER CONVERTER**  |  3003

**UNIT I**  |  **REVIEW OF SWITCH-MODE DC–DC CONVERTERS**  |  9


**UNIT II**  |  **STATE-SPACE AVERAGED MODEL**  |  9


**UNIT III**  |  **SLIDING MODE CONTROL AND HYSTERIS CONTROL**  |  9


**UNIT IV**  |  **FUZZY LOGIC CONTROL**  |  9


**UNIT V**  |  **STABILITY ANALYSIS OF POWER CONVERTERS**  |  9


**REFERENCES:**


**TOTAL : 45 PERIODS**
UNIT I OPERATING SYSTEM

UNIT II REAL TIME DEVICE DRIVERS
Mechanism and Policy, Device Drivers Using UNIX, Complex Real Time Device Drivers, Real Time Serial Line, Real Time Parallel Ports, Real Time Networking

UNIT III STUDY OF EXISTING EMBEDDED OPERATING SYSTEM

UNIT IV RTOS DESIGN AND IMPLEMENTATION
Design Principles, Pattern and Frame Work, Cross Compilation Debugging and Tracing, Design Example

UNIT V CASE STUDY
Study of Commercial RTOS, Case Studies of Programming with RTOS.

TOTAL : 45 PERIODS

REFERENCES:
### FE9011: INTELLIGENT CONTROLLER FOR ROBOTICS

**L T P C**

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<th>Item No.</th>
<th>FE15.02</th>
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</table>

**1. ARM ARCHITECTURE AND PROGRAMMING**

- RISC Machine – Architectural Inheritance – Core & Architectures

**2. TRANSPORT AND APPLICATION LAYERS**


**3. ONE DIMENSIONAL RANDOM VARIABLES**


**4. COMMUNICATION WITH BUSES FOR DEVICES NETWORKS**

- I/O devices: timer and counting devices, serial communication using I2C, CAN, USB.
- Buses: communication using profi bus, field bus, arm bus, interfacing with devices/serial port and parallel ports, device drivers.

**5. ARM APPLICATION DEVELOPMENT**


**REFERENCES:**

1. Steve Furber, ‘ARM system on chip architecture’, Addision Wesley
5. Siva Ramamurthy and B.B. Manoj, ‘Ad Hoc wireless network Architectures and protocols’
FE9012  EXPERIMENTAL STRESS ANALYSIS TECHNIQUES  3 0 0 3

UNIT 1
Normal stress, Normal strain, Poisson’s ratio, Young’s Modulus, Shear Strain, Shear stress, Shear modulus, Stress-strain diagram for various materials, Principal planes, Stress strain Transformation for different cases, Mohr’s circle, Beam bending, Shear force and bending moment diagrams, Deflection of beams, Thermal stresses, Stress tensor, Strain tensor, Compatibility conditions, Plane stress, Plane strain, Bi-harmonic equation, Airy’s stress function.

UNIT 2
Electrical properties of the strain gauges, Strain sensitivity, Materials used for strain gauges, Carrier materials, Adhesive materials, Bonding procedure, Different configuration of strain gauges, Study of change in resistance with strain for various strain gauge materials, Gauge factor, Cross sensitivity factor, Response of a strain gauge.

UNIT 3

UNIT 4
Wheatstone bridge circuit, Balancing, Sensitivity of circuit, Temperature compensation, measuring strain in beams and bar, Effect of resistance ratio, Power calculation, Advantages of Wheatstone bridge circuit, Total strain measurements, Static and Dynamic strain measurements, Full bridge circuit, Half bridge circuit, Quarter bridge circuit.

UNIT 5
Calibration of strain measuring circuits, Rosettes, Rectangular rosettes, Delta rosettes, T-rosettes, Stress gauges, Applications of strain gauges and stress gauges.

TOTAL: 45 PERIODS

TEXT BOOK:

REFERENCES:
FE9013  FINITE ELEMENT ANALYSIS OF BOUNDARY VALUE PROBLEMS  3 0 0 3

UNIT 1  9
Revision of analytical methods for solving ordinary differential equations: variable separable method, Bernoulli’s method; initial conditions and boundary conditions, finite difference methods, under standing the difference between numerical methods and classical methods, polynomial type approximate solutions and trigonometric type approximate solutions, essential boundary conditions, natural boundary conditions, domain residue, boundary residue, classification of classical methods.

UNIT 2  9
Weighted residual methods: Least square method, collocation methods, sub domain method, method of moments, Galerkin method, and modified Galerkin method.

UNIT 3  9
Different coordinate systems: Global coordinate system, local coordinate system, natural coordinate system. Interpolation functions for linear and quadratic elements, h-approximation, p-approximation, solving boundary value problems using classical methods with different elements (linear elements and quadratic elements), solving boundary value problems in different coordinate systems, element stiffness matrix, element load vector, global stiffness matrix, global load vector, reduced stiffness matrix, Gauss elimination procedure.

UNIT 4  9
Study of one dimensional structural mechanics problems: bar, truss, beam, column. Study of one dimensional potential problems: heat transfer, fluid flow, current flow. Different 2-d elements, Lagrangian Interpolation, shape functions for 2-d elements, iso-parametric, sub-parametric, super-parametric elements, Serendipity elements, Jacobian, EICJ and EILJ, constant strain triangle elements, linear strain triangle elements, Two dimensional boundary value problems.

UNIT 5  9
Numerical Integration, Gaussian Integration (one point, two points, three points), Finite element analysis on: time dependent, Eigen value and initial value problems convergence criteria, Banded symmetric matrix, Finite Element analysis software.

TOTAL: 45 PERIODS

TEXT BOOKS
2. Concepts and Applications of Finite Element Analysis, by Robert Davis Cook (Editor), David S. Malkus, Michael E. Plesha, Robert Davis
3. Concepts and Applications of Finite Element Analysis Cook (Editor), Robert Davis Cook (Editor), Robert D. Cook, Robert J. Witt. Hardcover, John Wiley & Sons Inc (October 2001)

REFERENCES :
1. Introduction to Finite Elements in Engineering, by Tirupathi R. Chandrupatla, Ashok D. Belegundu, Other, Prentice Hall (March 2002).
### Faulty of Electrical Engineering  
(Approved in 15th AC 13.02.2010)  
ITEM NO. FE 15.02(14)

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<tr>
<th>ITEM NO.</th>
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#### 1. ADAPTIVE CONTROL AND REALTIME PARAMETER ESTIMATION


#### 2. DETERMINISTIC, STOCHASTIC AND PREDICTIVE SELF TUNING REGULATOR


#### 3. MRAC ADAPTIVE SYSTEM


#### 4. DESCRIBING FUNCTION AND STATE SPACE BASED PROCESS IDENTIFICATION


#### 5. ONLINE TUNING AND GAIN SCHEDULING

Online tuning of controllers – Model based and model free tuning –Principle and design of gain scheduling controllers – Nonlinear transformations – Applications of gain scheduling – Robust high gain feedback control – Self oscillating adaptive systems.

**TOTAL : 45 PERIODS**

**TEXT BOOKS**
1. Astrom and Wittenmark, "Adaptive Control ", PHI.  

**REFERENCES**
FE9015  RECENT TECHNIQUES FOR RELIABLE DISTRIBUTION SYSTEMS  3 0 0 3

UNIT I  ADAPTIVE CONTROL AND ADAPTATION TECHNIQUES  9

UNIT II  HARMONIC ANALYSIS  9

UNIT III  FLICKER ANALYSIS  9
Sources of Flicker-Flicker Analysis-Flicker Criteria-Data for Flicker analysis- Case Study-Arc Furnace Load-Minimizing the Flicker Effects-Summary.

UNIT IV  ELECTRICITY PRICING - VOLATILITY, RISK AND FORECASTING  9

UNIT V  SUPPORT VECTOR MACHINES  9
Introduction – An overview – Classification – Pattern Classification - Linear Support Vector Machines – Non Linear Support Vector Machines.

TOTAL: 45 PERIODS

TEXT BOOKS

REFERENCES :
3. William S. Levine, “Control Hand Book”.
5. “Support vector machines "Steinwart, Ingo; Christmann, Andreas."
FE9016  DESIGN OF HIGH POWER SYNCHRONOUS GENERATOR  3 0 0 3

UNIT I  INTRODUCTION TO DESIGN OF RADIAL FLUX PMSG AND STUDY OF VARIOUS TOPOGRAPHIES  9

UNIT II  OPTIMUM STATOR DESIGN FOR MAXIMUM EFFICIENCY  9

UNIT III  OPTIMUM ROTOR DESIGN FOR MAXIMUM EFFICIENCY  9

UNIT IV  PERFORMANCE SIMULATION STUDIES OF RADIAL FLUX PMSG  9
Performance characteristics of radial flux PMSG using MAGNET software - Comparison of performance characteristics of various configurations - Saturation characteristics - Flux distribution – Losses – Thermal equivalent circuit[5] - Case Study for 1 MW machine

UNIT V  TESTING, COMMISSIONING AND COMPARISON OF TEST RESULTS WITH SIMULATION RESULTS  9
Acceptance test - Performance test - Parameter test under steady state – Sub-transient and transient parameter test - Standstill frequency response tests - Comparison of test results with simulation results[5] – Case Study for 1 MW machine

TOTAL: 45 PERIODS

REFERENCES:
FE 9017  MODELING AND SIMULATION OF SOLAR ENERGY SYSTEMS  

UNIT I  SOLAR RADIATION AND COLLECTORS  

UNIT II  APPLICATIONS OF SOLAR THERMAL TECHNOLOGY  

UNIT III  SOLAR PV FUNDAMENTALS  

UNIT IV  SOLAR PHOTOVOLTAIC SYSTEM DESIGN AND APPLICATIONS  
Solar cell array system analysis and performance prediction- Shadow analysis: reliability - solar cell array design concepts - PV system design - design process and optimization - detailed array design - storage autonomy - voltage regulation - maximum tracking - use of computers in array design - quick sizing method - array protection and trouble shooting - centralized and decentralized SPV systems - stand alone - hybrid and grid connected system - System installation - operation and maintenance - field experience - PV market analysis and economics of SPV systems.

UNIT V  SOLAR PASSIVE ARCHITECTURE  

TOTAL: 45 PERIODS

TEXT BOOKS:  
REFERENCES:
Faulty of Electrical Engineering  
(Approved in 16th AC (Ad hoc) 02.12.2010)  
ITEM NO. FE 16.02(2)

FE9018 SLIDING MODE AND ADAPTIVE CONTROL  L T P C  3 0 0 3

UNIT I  INTRODUCTION TO SMC, PASSIVITY AND FLATNESS  9

Dynamics in the sliding mode – linear system, non-linear system, chattering phenomenon – sliding mode control design – reachability condition, robustness properties – application – flatness, passivity properties through flatness, non-minimum phase output stabilization, trajectory planning.

UNIT II  STABILITY AND STABILIZATION  9


UNIT III  DETERMINISTIC, STOCHASTIC AND PREDICTIVE SELF TUNING REGULATOR  9


UNIT IV  DESCRIBING FUNCTION AND STATE SPACE BASED PROCESS IDENTIFICATION  9


UNIT V  ONLINE TUNING AND GAIN SCHEDULING  9

Online tuning of controllers – Model based and model free tuning – Principle and design of gain scheduling controllers – Nonlinear transformations – Applications of gain scheduling – Robust high gain feedback control – Self oscillating adaptive systems.

TOTAL: 45 PERIODS

TEXT BOOKS
1. Astrom and Wittenmark,” Adaptive Control “, PHI.

REFERENCES
UNIT I  INTRODUCTION

UNIT II  LOCALIZATION AND TIME SYNCHRONIZATION
Localization – Overview – Coarse grained node localization using minimal information – Fine grained node localization using detailed information – Network-wide localization – Theoretical analysis of localization techniques – Time synchronization - Overview –key issues – Fine grained clock synchronization – Coarse grained clock synchronization

UNIT III  MEDIUM ACCESS WITH SLEEP SCHEDULING
MAC protocols - Overview – Traditional MAC protocols – Energy efficiency in MAC protocols – Asynchronous sleep techniques – Sleep scheduled techniques – Contention free protocols – Sleep based topology control – Constructing topology for connectivity – Constructing topologies for coverage – Set K cover algorithms –Cross layer Issues

UNIT IV  ROUTING & DATA CENTRIC NETWORKING

UNIT V  CASE STUDIES

TOTAL: 45 PERIODS

TEXT BOOKS

REFERENCES:
2. MOHAMMAD ILYAS AND IMAD MAHGOUB, ‘Handbook of sensor Networks: Compact wireless and wired sensing systems’, CRC Press,2005
FE9020  HIGH ENERGY RADIATION EFFECTS ON POLYMERS AND L T P C
HIGH VOLTAGE TESTING OF POWER APPARATUS  3 0 0 3

UNIT I  GENERATION OF DIRECT, ALTERNATING, IMPULSE VOLTAGES AND MEASUREMENT OF HIGH VOLTAGES AND CURRENTS  9
Generation of High AC and DC Voltages- Generation of High Frequency High AC voltages- Generation of rectangular, square wave pulses-measurement techniques and study of equipments.

UNIT II  TESTING TECHNIQUES FOR ELECTRICAL EQUIPMENT  9
Type and nature of testing- Basic Insulation Level(BIL) of Power system- National and International Standards on Testing- Atmospheric Conditions and Correction factors- Testing of insulators, bushings, air break switches, isolators, circuit breakers, power transformers-voltage transformers-current transformers, surge diverters ,cables –testing methodology-recording of oscillograms – interpretation of test results.

UNIT III  NUCLEAR TECHNOLOGY AND AGEING  9

UNIT IV  GAMMA RAY IRRADIATION EFFECTS ON POLYMERS  9
Study of gamma ray irradiation inhibiting surface charge accumulation on polymers- Nuclear technology and ageing studies —Analysis of electrical and mechanical properties of polymers and their blends.

UNIT V  ELECTRON BEAM IRRADIATION ON POLYMERS  9
Study of di-electric and mechanical properties of electron beam irradiated polymer insulation materials-Study of electron beam irradiation effects on morphologic properties of the PET/PP/PE/EVA polymeric blends.

TOTAL: 45 PERIODS

REFERENCES :


UNIT I
INTRODUCTION TO BIFURCATION [1] 5
Introduction to bifurcation, Types of bifurcation SNB, HB, CFB, PDB, SIB, Torous and Intermittency. Mathematical background - Differential Equations (qualitative theory)- Differential-Algebraic systems- Multiple-time scales.

UNIT II
MODELING OF POWER SYSTEM COMPONENTS FOR BIFURCATION ANALYSIS [3,4] 10
Modeling of Synchronous Generators (Type 0, 1B, 1A, 2B, 2A), excitation systems, transformer, transmission line, PSS, LTC, and FACTS Controllers- Different types of wind turbine generators SCIG, DFIG and PMSG - Modeling of Grid integrated solar conversion system and other Grid integrated Renewable energy sources.

UNIT III
METHODS AND TOOLS FOR BIFURCATION ANALYSIS OF NON-AUTONOMOUS SYSTEM [1, 2, 4] 10
Algorithm for tracing local and global bifurcation diagrams for ODE systems with single variations. Bifurcation diagrams: time response plot, Phase plane and Poincare maps.

UNIT IV
METHODS AND TOOLS FOR BIFURCATION ANALYSIS OF AUTONOMOUS SYSTEM [1, 2, 4] 10
Algorithm for tracing local and global bifurcation diagrams for ODE and DAE systems with single and multi-parameter variations- Bifurcation diagrams: time response plot, Phase plane and Poincare maps. PB Theorems.

UNIT V
CASE STUDY [2,4,5,6,7] 10
Simulation of the single parameter Bifurcation diagram: ODE and DAE power systems - Analysis with the use of simulation software packages - coding for the sample power system.

L = 45 T =15 TOTAL = 60 PERIODS

REFERENCES
7. www.matcont.ugent.be/
FE9022  POWER QUALITY ANALYSIS FOR GRID INTEGRATED RENEWABLE ENERGY  

UNIT I  RENEWABLE ENERGY  

UNIT II  ENERGY STORAGE SYSTEMS  

UNIT III  GRID INTEGRATION OF RENEWABLE ENERGY  
Renewable Power and Grid Stability - Connection and Operational Requirements (Grid Codes) - Integration in Existing Grid / Barriers - Decentralized Generation / Future Integration - Advanced Renewable Energy Technology Solutions for Grid Integration.

UNIT IV  POWER QUALITY ISSUES  

UNIT V  MITIGATION TECHNOLOGIES  

L: 45+T:15 = 60 PERIODS

REFERENCES:
FE9023   OPTIMIZATION TECHNIQUES IN DESIGN   L T P C
                                                  3 0 0 3

UNIT I   INTRODUCTION                                5
Problem formulation, degree of freedom analysis, objective functions, constraints and feasible region, Types of optimization problem.

UNIT II  UNCONSTRAINED OPTIMIZATION TECHNIQUES        10
Introduction to optimum design - General principles of optimization – Problem formulation & their classifications - Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, Random, pattern and gradient search methods – Interpolation methods.

UNIT III CONSTRAINED OPTIMIZATION TECHNIQUES         10
Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions, Lagrange multipliers - Geometric programming

UNIT IV  MULTI OBJECTIVE OPTIMIZATION                10
Weighted Sum of Squares method, Epsilon constrains method, Goal attainment Examples. Introduction to optimal control and dynamic optimization

UNIT V   ADVANCED OPTIMIZATION TECHNIQUES             10
Multi stage optimization – dynamic programming; stochastic programming; Multi objective optimization, Genetic algorithms and Simulated Annealing techniques; Neural network & Fuzzy logic principles in optimization.

TOTAL : 45 PERIODS

REFERENCES:
UNIT I  AC – AC CONVERTERS  9
Introduction-AC-AC Voltage Controllers, Cycloconverters — single phase ,three phase,Control scheme, Cycloconverter harmonics & I/P current, Power quality Issues, Forced commutated cycloconverter, Matrix Converter.

UNIT II  MATRIX CONVERTERS  9
Basic circuit, Bidirectional switches, single phase, three phase, mathematical modelling, Switching algorithm, Commutation methods, I/P filter and O/P filter, Unbalanced supply and Load conditions.

UNIT III  MODULATION TECHNIQUES  9
Operation and modulation techniques of Matrix Converter-Venturini – Modified Venturini –, SVPWM-Indirect Transfer function - scalar modulation algorithm, protection Issues. Power regulation – Control of reactive power.

UNIT IV  CONTROLLER DESIGN & APPLICATIONS  9
PID controller, Neuro controller, Fuzzy controller, Neuro fuzzy , PR controller. Applications – For Induction motor drives, Hybrid vehicle applications, Frequency changing power supply applications, aircraft applications, Renewable Energy applications.

UNIT V  MATRIX CONVERTER FOR WIND ENERGY CONVERSION SYSTEMS  9
Introduction , Advantages of MC applied to Wind Energy Conversion Systems(WECS), Comparison of WECS technologies, Modelling and simulation of wind energy systems with matrix converters – PMSG wind turbine system, DFIG wind turbine system, SCIG wind turbine system.

TOTAL : 45 PERIODS

REFERENCES:
2. S.N.Bhadra “WIND ELECTRICAL SYSTEMS”, Oxford University Press, 2005
FE9025 ENERGY TECHNOLOGIES AND MAGNETIC ENERGY STORAGE SYSTEM

UNIT I INTRODUCTION
Development in the field of superconductivity, Basic parameters of superconductivity, Types of superconductors, BCS theory, Meissner Effect, Josephson effect in Superconductors. High Tc Superconductors, Cuprate Superconductors; La, Y, Bi, Tl and Hg based superconductors, Intermetallic MgB2 superconductor crystal structure and superconducting properties, conduction mechanism.

UNIT II SYNTHESIS OF HIGH TC SUPERCONDUCTORS
Introduction, Different methods of synthesis of High Tc superconductors; electro deposition, electrophoretic method, spray pyrolysis technique, solid state reaction method, screen printing, Pulse laser deposition method (PLD), Powder in tube method (PIT), combustion method, sol-gel method, Electro deposition of alloys; DC electrode position, Mechanism of electrodeposition, Post deposition treatments.

UNIT III APPLICATIONS OF SUPERCONDUCTORS IN ENERGY
Superconducting wires and their characteristics, High field magnets for production of energy by magnetic fusion, Energy generation - Magneto hydrodynamics (MHD), energy storage, electric generators and role of superconductors.

UNIT IV MAGNETIC AND ELECTRIC ENERGY STORAGE SYSTEMS
Superconducting Magnet Energy Storage (SMES) systems; Capacitor and Batteries: Comparison and application; Super capacitor: Electrochemical Double Layer Capacitor (EDLC), principle of working, structure, performance and application, role of activated Carbon and carbon nano-tube.

UNIT V EXPERIMENTAL TECHNIQUES
Low temperature resistivity measurements; Four probe and Vander Paw resistivity technique, AC and DC susceptibility measurements, SQUID measurements, Different types of cryostat, Closed cycle refrigerators system.

TOTAL 45 PERIODS

TEXT BOOKS:
2. Preliminary investigation of small scale superconducting magnetic energy storage (SMES) systems by J. Schwartz, Publisher: US Army Corps of Engineers, Construction Engineering Research Laboratories National Technical Information Service, distributor

REFERENCES:
UNIT I INTRODUCTION
Classification of Stability-Types of WECS- Fixed speed wind generator - Variable speed wind generator - FACTS- Basic concepts- Static Var Compensator (SVC), Static Synchronous Compensator (STATCOM), Thyristor Switched Series capacitor (TCSC), Static Series Synchronous Compensator (SSSC) and Unified power flow controller (UPFC).

UNIT II MODELLING OF WIND FARMS FOR LOAD FLOW ANALYSIS
Aggregated modelling of wind farms for load flow analysis-Different types of aggregation-Simulation.

UNIT III MODELLING OF WECS AND FACTS FOR STABILITY
Modelling of synchronous generators (Type 0, 1B, 1A)-Modelling of Wind turbine, Squirrel cage Induction generator (SCIG), Doubly Fed Induction Generator (DFIG) – Introduction to vector control- Modelling of SVC, STATCOM-TCSC.

UNIT IV SMALL SIGNAL STABILITY ANALYSIS

UNIT V TRASIENT STABILITY ANALYSIS

TOTAL: 45 PERIODS

REFERENCES:

7. Modeling of Wind
8. Load flow analysis for variable speed offshore wind farms by M.Zhao et al.,
9. Small signal stability analysis of large scale variable speed wind turbines integration by Xiangi Li et.al,
10. Modeling and performance of fixed-speed induction generators in power system oscillation stability studies by Jian Zhang et al.,
11. Small Signal stability analysis of Wind Turbines with Squirrel Cage Induction Generators by Yuri Ullianov Lopez et al.,
12. Ph.d Thesis,“ On the Use of Wind Power for Transient stability Enhancement of Power systems” by Katherin Elkington, Royal Institute of Technology,
13. Ph.d Thesis,” Small signal modeling and Analysis of DFIG in wind power application” by Francoise Mei, University of London,
UNIT I  INTRODUCTION  6
Power system optimisation-Emerging optimisation techniques and its application in Power system-Simulated annealing applications-Multi-objective optimisation-Constrained and Unconstrained Optimization problems.

UNIT II  CONVENTIONAL METHODS  9

UNIT III  GENETIC ALGORITHM  9
 Genetic Algorithm- Genetic Algorithm for Unit Commitment-Problem formulation-Generator maintenance scheduling using Genetic Algorithm-Transmission Network Planning problem- Genetic Algorithm model for Transmission Network Planning-Ant colony search algorithms -Tabu search-Particle Swarm Optimization technique

UNIT IV  ARTIFICIAL NEURAL NETWORK AND FUZZY BASED OPTIMISATION TECHNIQUES  12

UNIT V  CASE STUDIES  9

TOTAL: 45 PERIODS

REFERENCES :
UNIT I  OCEANOGRAPHIC AND MARINE SURVEY INSTRUMENTATION  9
Basic studies on Ocean profilers – conductivity – salinity – temperature - depth and pressure sensors / instruments - sampling system for deep sea water - current meter - sea bed system - Echo sounder, multibeam sonar - sub bottom profiler - side scan sonar.

UNIT II  PHYSICAL OCEANOGRAPHY  9

UNIT III  UNDER WATER SYSTEM BASIC DESIGN PROCESS  9
Introduction - overall perspective - input to submersible system design - basic design of manned submersible - Electrical power distribution systems and lighting systems for underwater application

UNIT IV  OCEAN ENVIRONMENT AND VEHICLE SUPPORT SYSTEMS  9
Introduction - physical properties of sea water - dynamical processes - The geography of the world’s ocean basins - Transportation systems - Navigation and position aids - Motion compensation techniques - General safety consideration of underwater system - Design of control systems,

UNIT V  CONTROL AND REGULATION ELEMENTS  9
Direction flow and pressure control valves-Methods of actuation, types, sizing of ports-pressure and temperature compensation - Overlapped and underlapped spool valves-operating characteristics-electro hydraulic servo valves-Different types-characteristics and performance.

TOTAL : 45 PERIODS

REFERENCES:


UNIT I  TRANSISTOR MODELS FOR ANALOG DESIGN  
Long channel and short channel MOSFETs; The square law equations for nMOS and pMOS; Threshold voltage and body effect; Transconductance; AC Analysis; Transient analysis; Transition frequency; Temp effects; MOSFET noise modeling.

UNIT II  CMOS INVERTER AND CURRENT MIRRORS  
Inverter DC characteristics and switching characteristics; Noise Margins for inverter VTC; Inverter transistor sizing for large loads; Basic current mirrors; Biasing and referencing current mirrors for both long channel and short channel transistors; Cascoding the current Mirror for wide swing; Biasing circuits for long channel and short channel transistors.

UNIT III  CMOS AMPLIFIERS AND DIFFERENTIAL AMPLIFIERS  
Gate-Drain connected Transistor loads; Current source loads; Common source Amplifier-Miller compensation, Pole splitting, cancelling RHP zero; Cascode Amplifier; Source follower; Push pull Amplifier; Source coupled Differential Amplifier; Source cross coupled Diff Amplifier; Cascode and wide swing Diff Amplifier; DC operation; AC operation; CMRR; Slew rate limitations; Input signal range and Noise performance.

UNIT IV  OPERATIONAL AMPLIFIERS  
Two stage op-Amp; Buffered Amplifier output; Operational Transconductance Amplifier; Gain Enhancements, CMRR, PSRR, Gain Margin, Phase Margin, Input Common-Mode voltage range, Bandwidth; Biasing op-Amp for power and speed; Common mode feedback Amplifier.

UNIT V  DATA CONVERTERS – BASICS AND ARCHITECTURE  
ADC,DAC Basics – Analog Vs Discrete Time signals; Sample and Hold circuits; Differential Nonlinearity, Integral nonlinearity, offset, Gain error, latency, SNR, Dynamic range, aliasing; DAC architectures- Digital input code, R-2R ladder network, Current steering, pipeline DAC; ADC Architecture – Flash, Two step flash, pipeline ADC, SAR ADC, oversampling ADC.

TOTAL : 45 PERIODS

TEXT BOOK:
REFERENCES:

UNIT I  INTRODUCTION TO MICRO GRID

UNIT II  MULTIAGENT SYSTEMS

UNIT III  INTERACTION LANGUAGES
Ontology Languages: Agent Communication Languages, KQML, the FIPA Agent Communication Language. ZEUS tool kit.

UNIT IV  WIND AND SOLAR PHOTOVOLTAIC SYSTEM

UNIT V  CASE STUDIES MICRO GRID
Simulation on Stand-Alone System, Hybrid systems using MATLAB, LABVIEW and ZEUS.

REFERENCES

TOTAL : 45 PERIODS
UNIT I  PIEZOELECTRIC ENERGY HARVESTING

UNIT II  Electromagnetic Energy Harvesting

UNIT III  ENERGY HARVESTING CIRCUITS AND ARCHITECTURES

UNIT IV  THERMOELECTRIC ENERGY HARVESTING

UNIT V  APPLICATIONS OF ENERGY HARVESTING SYSTEMS

TOTAL : 45 PERIODS

REFERENCES:
UNIT I BASIC PROPERTIES OF ELECTRIC FIELDS IN COMPOSITE DIELECTRICS

Background – Fundamentals of Composite Dielectric Fields - Effect of Conduction – Outline of Field Behavior near a Contact Point.

UNIT II ELECTRIC FIELD BEHAVIOR FOR A FINITE CONTACT ANGLE

Analytical Treatment – Numerical Treatment – Effect of Volume and Surface Conduction

UNIT III ELECTRIC FIELD FOR A ZERO CONTACT ANGLE


UNIT IV ELECTRIC FIELD BEHAVIOR FOR THE COMMON CONTACT OF THREE DIELECTRICS

Contact of Straight Dielectric Interfaces – Perpendicular Contact of a Solid Dielectric with Another Solid – Numerical Analysis of Field Behavior.

UNIT V ELECTRIC FIELD IN HIGH VOLTAGE EQUIPMENT

Finite Contact Angle: Prevention of Field Singularity near a Contact Point – Zero Contact Angle in Gas Insulated Equipment – Common Contact of Three Dielectrics – Application of High Field Emission Devices.

TOTAL : 45 PERIODS

REFERENCES
UNIT I ARM PROCESSOR 9
ARM Processor Fundamentals, Introduction to the ARM Instruction set, Efficient C Programming, Digital Signal Processing, Memory Management Units, Simple Interface programs.

UNIT II OMAP PROCESSOR 9
Introduction, architecture, instruction set, addressing modes, applications – Interface to I/O.

UNIT III OMAP AM/DM 37x PROCESSOR 9
Functional block diagram, Key features, Memory and I/O Mapping, I/O Interface, Power Module, Case study.

UNIT IV UBUNTU OPERATING SYSTEM 9
Introduction, Features, Building a Ubuntu Linux host under Virtual-box, Configuring Virtual Machine, Installing Ubuntu on the Virtual machine, Sharing files between Ubuntu and windows. Configuring a Proxy in Ubuntu, Case study.

UNIT V ANDROID 9
Introducing Android, Key Concepts, Designing the User Interface, Multimedia, Storing local data, case study

TOTAL : 45 PERIODS

REFERENCES
8. AM37x EVM SDK 4.00 Release Notes, 2010.

UNIT I 9
Types of faults in Induction motors, Condition monitoring of Induction motors, Study of faults in Inverter-fed Machines
UNIT II

UNIT III

UNIT IV
Use of Analysis tools, Fourier transforms, power spectrum, correlation methods, windowing and filtering. Application of VI in process control designing of equipments like oscilloscope, Digital multi meter, Design of digital Voltmeters with transducer input Virtual Laboratory.

UNIT V
Distributed I/O modules – Application of Virtual Instrumentation: Development of process database management system, Simulation of systems using VI, Development of Control system, Image acquisition and processing, Development of Virtual Instrument using GUI.

TOTAL : 45 PERIODS

TXT BOOKS:

REFERENCES:
UNIT I   ELECTROMAGNETIC ENERGY CONVERSION  9
General expression of stored magnetic energy, Co-energy and force/torque – Calculation of air-gap MMF and per phase machine inductance using physical machine data – Reference frame theory.

UNIT II   SPECIAL ELECTRICAL MACHINES  9
Principle of operation of Stepper motors - Switched Reluctance Machines - Brushless DC Machines - Axial Flux Permanent Magnet Machines

UNIT III   PRINCIPLES OF AXIAL FLUX PERMANENT MAGNET MACHINES  9

UNIT IV   CHARACTERISTICS OF AFPM MACHINES AND CONTROL  9
AFPM machines with iron core – without stator core – without stator and rotor cores - Control

UNIT V   COOLING AND HEAT TRANSFER OF AFPM MACHINE  9

TOTAL : 45 PERIODS

REFERENCES
UNIT I  Introduction to Solar  9
Semiconductor – properties - energy levels - basic equations of semiconductor
devices physics - Basic characteristics of sunlight - Solar angles - day length -
angle of incidence on tilted surface – Sun path diagrams – Equivalent circuit of
PV cell , PV cell characteristics (VI curve, PV curve) - Maximum power point,
Vmp, I_{MP}, V_{oc}, I_{SC} – types of PV cell - Block diagram of solar photo voltaic
system, PV array sizing.

UNIT II  DC-DC Converter  9
Principles of step-down and step-up converters – Analysis of buck, boost, buck-
boost and Cuk converters – time ratio and current limit control – Full bridge
converter – Resonant and quasi – resonant converters.

UNIT III  Charge Controllers  9
Direct Energy transmission, Impedance Matching, Maximum Power Point
Tracking (MPPT) - Function of MPPT, P&O method, INC Method, Fractional
Open circuit voltage method, Fractional short circuit current method, parasitic
capacitance and other MPPT techniques.

UNIT IV  Battery  9
Types of Battery, Battery Capacity – Units of Battery Capacity - impact of charging
and discharging rate on battery capacity - Columbic efficiency - Voltage Efficiency,
Charging – Charge Efficiency, Charging methods, State of Charge, Charging
Rates, Discharging - Dept of discharge-Discharge Methods, Battery Management
System (BMS), selection of Battery.

UNIT V  Simulation of PV Module & Converters  9
Simulation of PV module - VI Plot, PV Plot, finding V_{MP}, I_{MP}, V_{oc}, I_{SC} of PV module
Simulation of DC to Dc converter - buck, boost, buck-boost and Cuk converters.
Simulation of solar photo voltaic system.

TOTAL: 45 PERIODS

REFERENCES:
1. Tommarkvart, Luis castaner, “Solar cells; materials, manufacture and
4. Ned Mohan, Undeland and Robbin, “Power Electronics: converters,
5. Rashid M.H., “Power Electronics Circuits, Devices and Applications”, Prentice
Hal India, New Delhi, 1995.
7. Valer Pop, “ Henk Jan Bergveld” Battery Management Systems
springer publication, 2008.
Renningen Malsheim, Germany 2003.
UNIT I  STATIC RELAYS

UNIT II  NUMERICAL RELAYS AND ITS APPLICATION
Introduction - principles of numerical relay - fault locators - protection and coordinated control - numerical relaying, algorithm for over current, distance and differential protection with application to Generator, transmission system, transformers and bus bar protection.

UNIT III  ISLANDING PROTECTION OF DISTRIBUTION SYSTEMS WITH DISTRIBUTED GENERATORS

UNIT IV  GRID PROTECTION USING COMMUNICATION – ASSISTED DIGITAL RELAYS

UNIT V  RECLOUSER ALLOCATION FOR IMPROVED RELIABILITY OF DG-ENHANCED DISTRIBUTION NETWORKS

TOTAL: 45 PERIODS

TEXT BOOKS

REFERENCES