DIT UNIVERSITY
Dehradun

COURSE STRUCTURE
OF
M.Tech. in Electrical Engineering
(Power Systems)
Batch 2018–20

Amended by the BoS and approved by the Academic Council at its 9th Meeting held on 14.04.2018
Department of Electrical Engineering
Curriculum Structure for
M.Tech Program in Electrical Engineering (Power Systems)
Batch: 2018-20

Year: 1st Semester: I

<table>
<thead>
<tr>
<th>Course Category</th>
<th>Course Code</th>
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Year: 1st Semester: II

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List of Electives:

First Year

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<td>2.</td>
<td>EE643</td>
<td>Generalized Theory of Electrical Machines - Elective I</td>
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<td>Power Converters - Elective II</td>
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<td>Power Electronics for Renewable Energy Systems - Elective III</td>
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## Department of Electrical Engineering

### Curriculum Structure for M.Tech Program in Electrical Engineering (Power Systems)

**Batch: 2018-20**

### Year: 2\textsuperscript{nd} Semester: III

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<th>Course Category</th>
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### List of Electives:

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<td>EE751</td>
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<td>12.</td>
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Summary of the Credits

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<th>Year</th>
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Department of Electrical Engineering  
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<table>
<thead>
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<th>Subject Code</th>
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UNIT-I  
Numerical Techniques  
Zeros of Transcendental and Polynomial equation using bisection method, Newton-Raphson method, Rate of convergence of above methods. Interpolation: Finite differences, difference tables, Newton’s Forward and Newton’s Backward Interpolation, Lagrange’s and Newton divided difference formula for unequal intervals. Solution of system of Linear equations, Gauss-Seidal method, Crout method. Numerical Integration: Trapezoidal rule, Simpson’s one-third rule, Simpson’s three-eighth rule, Solution of ordinary differential (first order, second order and simultaneous) equations by Picard’s and Fourth order Runge - Kutta methods

UNIT-II  
Partial Differential Equations (PDE)  

UNIT-III  
Special Functions  
Series solution of ODE of 2nd order with variable coefficient with special emphasis to Legendre and Bessel differential equation, Legendre polynomial of first kind, Bessel Function of first kind and their properties.

UNIT-IV  
Statistics:  
Elements of statistics, frequency distribution: concept of mean , median, mode, Standard derivation , variance and different types of distribution: Binomial, Poisson and Normal distribution, curve fitting by least square method, Correlation and Regression, Concept of Hypothesis Testing.

UNIT-V  
Optimization:  
Formulation, Graphical method, Simplex method, Two-Phase simplex method, Duality, Primal-dual relationship, Dual-simplex method.

Text Books:  

Reference Books:  

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**Batch: 2018-20**

<table>
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<th>Subject Code</th>
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### REVIEW OF MODELING AND ANALYSIS OF LTI SYSTEMS:

### ANALYSIS IN STATE-SPACE:
A perspective on state-space design, State variables, State models for physical systems, SISO and MIMO systems, Solution of state equations. Transfer function, Eigenvalues and eigenvectors, Jacobian linearization technique, State transformations and diagonalisation, Transformation to phase-variable canonical form, Controllability and observability, Duality property, Stability.

### INTRODUCTION TO DISCRETE-TIME SYSTEMS:
Basic elements of discrete-time control system, Z-transform and properties, Inverse Z-transform, Difference equation and its solution by Z-transform method, Z-transfer function, State diagram of digital systems, Time delay, Direct, cascade and parallel decomposition of Z-transfer functions.

### FEEDBACK CONTROL DESIGN:
Continuous control design, Proportional, derivative and integral control action, PID controller tuning rules, Ziegler-Nichols method, Two degree of freedom control systems, Compensator design using Bode diagram in frequency response approach, Lag, Lead, Lag-lead compensator, Control law design for full state feedback by pole placement, Full order observer system, Observer based state feedback, Separation principal.

### NON LINEAR SYSTEM:

### REFERENCE BOOKS:
1. Ogata, K – *Modern Control Engineering*, PHI Learning
Department of Electrical Engineering
Curriculum Structure for
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<table>
<thead>
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<th>Subject Code</th>
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REVIEW OF POWER SEMICONDUCTOR DEVICES:
Review of Semiconductor devices like Power BJT, SCR, MOSFET, IGBT, GTO, MCT; Static and dynamic characteristics of these devices; Single quadrant, Two quadrant and bidirectional switches.

SWITCHING VOLTAGE REGULATORS:
Introduction; Linear power supply (voltage regulators); Switching voltage regulators; Review of basic dc-dc voltage regulator configurations like Buck, Boost, Buck-Boost converters and their analysis for continuous and discontinuous mode; Other converter configurations like Flyback converter, Forward converter, Half bridge, Full bridge configurations, Push-pull converter, Cuck convert, design criteria for SMPS; Multi-output switch mode regulator.

INVERTERS:
Classification; Review of line commutated inverters; Bridge inverters with 120°, 180°, and 150° modes of operation; Harmonic reduction techniques; Sine-triangular PWM; Space Vector Pulse Width Modulation; Current Source Inverters.

GATE AND BASE DRIVE CIRCUITS:
Preliminary design considerations; DC coupled drive circuits with unipolar and bipolar outputs; Importance of isolation in driver circuits; Electrically isolated drive circuits; Some commonly available driver chips (based on boot-strap capacitor); Cascade connected drive circuits; Thyristor drive circuits; Protection in driver circuits; Blanking circuits for bridge inverters.

MULTI-LEVEL CONVERTERS:
Bridge inverters, Need for multi-level inverters, Concept of multi-level, Topologies for multi-level: Diode Clamped, Flying capacitor and Cascaded multi-level configurations; Features and relative comparison of these configurations; Switching device currents; DC link capacitor voltage balancing, features of multi-level converters, Applications. 4 quadrant operation of dc-dc converters.

REFERENCE BOOKS:
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<table>
<thead>
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<th>Subject Code</th>
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**REFERENCE BOOKS**
1. R Krishnan, *Electric Motor Drives*, PHI
2. D W Novotny and T A Lipo, *Vector Control and Dynamics of AC Drives*, Oxford University Press
4. Leonhard, *Control of Electric Drives*, Springer

*Amended by the BoS and approved by the Academic Council at its 9th Meeting held on 14.04.2018*
INTRODUCTION:
Unified approach to the analysis of electrical machine – basic two-pole machine – Kron’s primitive machine – voltage, power and torque equation – linear transformation from 3-phase to 2-phase - transformation from rotating axes to stationary axes – power invariance – park’s transformation for 3-phase synchronous and induction machines.

INDUCTION MACHINES:
3-phase induction machine- generalized model – voltage equation – electric transients in induction machines – applications in speed control of induction machine – induction motor modeling in arbitrary reference frame and in field oriented frame

POLYPHASE SYNCHRONOUS MACHINES:

REFERENCE BOOKS
1. PS. Bhimbra, Generalized Theory of Electrical Machines, Khanna Publishers
2. Krauss, Wasyncuk and Sudholf, Analysis of Electrical Machines and Drive Systems, John Wiley
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M.Tech Program in Electrical Engineering (Power Systems)  
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**ARTIFICIAL NEURAL NETWORKS-I**
Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron and convergence theorem, Adaline and Madaline, Feed-forward Multilayer Perceptron. Learning and Training the neural network.

**ARTIFICIAL NEURAL NETWORKS-II**
Back propagation-RBF algorithms-Hope field networks, Introduction to Kohanan’s Self organization map, architecture and algorithms and recurrent network.

**FUZZY LOGIC SYSTEMS** - Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate Reasoning, Fuzzification, Membership value assignment, inference and defuzzification. Fuzzy knowledge and rule bases. Self-organizing fuzzy logic control.

**GENETIC ALGORITHM** - Basic concept of Genetic algorithm Mutation, Reproduction and crossover and detail algorithmic steps. Engineering applications.

**APPLICATIONS FUZZY LOGIC**: Design of Fuzzy PI controller for speed control of DC motor using Matlab fuzzy-logic toolbox. Inverted pendulum Neuro controller, GA with examples

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**GENERALIZED MEASUREMENT SYSTEMS:**
System concept of measurement schemes, Generalized performance characteristics of measurement systems. Error Analysis: types of errors, Methods of error analysis, uncertainty analysis, statistical analysis, and propagation of errors.

**SENSORS & TRANSDUCERS:**
Classification, selection of Transducer, transducer conditioning, transducer selection and specification, capacitive transducer, inductive transducer, resistive transducer, electromagnetic transducer, magnetostrictive transducer, photosensors, hall effect sensors. Smart Sensors.

**DATA ACQUISITION:**
Introduction to data acquisition, Sampling fundamentals, Input/output techniques and buses. ADC, DAC, Digital I/O, Data acquisition interface requirements. Signal conditioning, DAQ hardware configuration.

**RADIATION DETECTION:**
Ionization Chamber, Geiger Muller Counter, Proportional Counter, scintillation Counters. Methods of data

**TRANSMISSION:**
General telemetry systems, DC & AC telemetry system, Modulation, Pulse telemetry systems, Digital telemetry.

**REFERENCES:**
1. D. Partanabis Instrumentation and control
2. D. Partanabis Sensors and transducers
3. E. O. Doeblin Measurement Systems
4. E. Frank Electrical Measurement Analysis
5. Foard &Hauge A.C. Bridge Methods
6. B.S.Sonde Transducer and Display Systems
7. W. D. Cooper Electrical Instrumentation & measurement Techniques

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<table>
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<th>Subject Code</th>
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ENERGY SCENARIO:
Energy sources, security, conservation, strategy, Basics of Energy and its various forms, Regulatory mechanism in power system, Electricity safety rules and regulations.

ENERGY MANAGEMENT & AUDIT:
Energy costs, Bench marking, efficiency, audit instruments, Energy Action Planning: Role, motivation, training, information systems.

ENERGY MONITOR OF ELECTRICAL SYSTEM:
Power supply, Electricity billing, Electrical load management and maximum demand control, Power factor improvement and its benefit, Selection and location of capacitors, Performance assessment of PF capacitors, Distribution and transformer losses.

ENERGY EFFICIENT MOTORS:

LIGHTING SYSTEM:
Light source, Choice of lighting, Luminance requirements, and Energy conservation avenues.

ENERGY EFFICIENT TECHNOLOGIES IN ELECTRICAL SYSTEMS:
Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, and Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic ballast, Occupancy sensors, and Energy efficient lighting controls.

REFERENCE BOOKS
1. Albert: Plant Engineers & Managers Guide to Energy Conservation
2. Wayhe Tuner: Energy Management Handbook
INTRODUCTION TO OPTIMIZATION:

CLASSICAL OPTIMIZATION TECHNIQUES: Single variable optimization, Multivariable optimization with no constraints, Multivariable optimization with equality constraints, Multivariable optimization with in equality constraints.

LINEAR PROGRAMMING: Standard form of linear programming, Graphical solution, Simplex method, Twophase simplex method, Computer implementation of the simplex method, Duality theory.

TRANSPORTATION PROBLEM: North-West Corner rule, Least cost method, Vogel approximation method, testing for optimality.

NON-LINEAR PROGRAMMING:
One—Dimensional Minimization Methods:

Constrained Optimization Techniques:
Interior Penalty function method, Exterior penalty function method, Method of Multipliers, KKT Conditions

FURTHER TOPICS IN OPTIMIZATION:
Critical path method (CPM), Program evaluation and review technique (PERT). Multiobjective Optimization Techniques, Weighting method, ε- constraint method. Simulated annealing method

REFERENCES:
## ANALYSIS OF SWITCHED CIRCUITS

## IMPROVED P.F. CONVERTERS
Fully controlled and half controlled converters, Controlled freewheeling, sequence control of converters, simultaneous control of converters, PWM converters, power factor improvement techniques

## DC-DC SWITCH MODE CONVERTERS
DC-DC converter systems – control of DC-DC converters, Buck converters – Continuous and discontinuous modes – Boost converters – continuous and discontinuous modes – Buck boost converters – continuous and discontinuous and discontinuous modes. Cuck converters – continuous and discontinuous models – DC-DC converter comparison; ZVS and ZCS resonant converters.

## CHOPPERS
Classification of DC chopper circuits – analysis of type A chopper and type B chopper – voltage, current and load commutation of choppers – step up chopper – pulse width modulated AC choppers – Current topologies and Harmonic elimination methods.

## INVERTERS
Characteristics – output voltage and waveform control – bridge inverters – single phase and three phase versions – multilevel inverters: diode clamped MLI, flying capacitor MLI, cascade MLI,

## REFERENCE BOOKS

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<table>
<thead>
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<th>Subject Code</th>
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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.

POWER CONVERTERS
Solar: Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing
Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

ANALYSIS OF WIND AND PV SYSTEMS
Stand alone operation of fixed and variable speed wind energy conversion systems and solar system-Grid connection Issues -Grid integrated PMSG and SCIG Based WECS Grid Integrated solar system.

HYBRID RENEWABLE ENERGY SYSTEMS
Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV Maximum Power Point Tracking (MPPT).

REFERENCE BOOKS
ENERGY RESOURCES:
Renewable energy sources, Environment, Energy and Global Climate Change energy parameters, cogeneration, rational use of energy, energy efficiency and conservation, distributed energy systems and dispersed generation, atmospheric aspects of electric energy generation, Impact of renewable energy generation on environment, GHG emissions from various energy sources, Electromagnetic Radiation from Extra High Voltage Overhead lines

SOLAR ENERGY:

WIND ENERGY:

GEOTHERMAL ENERGY:
Structure of the Earth's Interior, Plate Tectonic Theory, Geothermal Sites, Geothermal Field, Geothermal Gradients, Geothermal Resources, Geothermal Power Generation, Geothermal Electric Power Plant, Geothermal-Preheat Hybrid with Conventional Plant

OCEAN ENERGY:

FUEL CELLS:

HYDROGEN ENERGY SYSTEM: Hydrogen Production, Hydrogen Storage, Development of Hydrogen Cartridge, Gas Hydrate


REFERENCES:
1. Kothari DP, Singal KC and Ranjan Rakesh, Renewable energy sources and emerging technologies, 2nd ed, Prentice Hall (India)
### Subject Title: Special Electric Machines

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<tr>
<th>Subject Code</th>
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#### STEPPER MOTOR:
Introduction, Types, Hybrid stepper motor- construction, principle of operation, two phases energized at a time, conditions for operation, different configurations, VR Stepper motor- single stack and multi stack, Drive systems and circuit for open loop and Closed loop control of stepping motor. Dynamic characteristics. Single phase stepper Motor, Expression of voltage, current and torque for stepper motor and criteria for synchronization.

#### SWITCHED RELUCTANCE MOTOR:
Constructional features, principle of operation, Design Aspects and profile of the SRM, Torque equation, Power converters and rotor sensing mechanism, expression of torque and torque-speed characteristics.

#### PERMANENT MAGNET MATERIALS:
Permanent magnet materials, properties, minor hysteresis loop and recoil line, equivalent circuit, stator frames with permanent magnets.

#### BRUSHLESS DC MOTOR:
Construction, operation, sensing and switching logic scheme, Drive and power circuit, Theoretical analysis and performance prediction, transient Analysis.

#### LINEAR INDUCTION MOTOR:
Construction and principle of operation of Linear Induction Motor, Approximate calculation of the force on rotor.

#### REFERENCE BOOKS
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<th>Subject Code</th>
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GENERALIZED ROTATING ELECTRICAL MACHINE THEORY:
Introduction, magnetically coupled circuits, electromechanical energy conversion, machine windings and air-gap MMF-Winding inductances and voltage equations, Equation of transformation, stationary circuit variables transformed to the arbitrary reference frame- commonly used reference frames, transformation of a balanced set, balanced steady state phasor relationships, balanced steady state voltage equations, variables observed from several frames of reference.

STEPPER MOTORS:
Construction of stepper motors and types of stepper motors various modes of operation of Variable reluctance (VR) stepper motor, construction and working Multi stack VR stepper motor, Construction and working of Permanent Magnet (PM) stepper motor, Construction and working of Hybrid stepper motor, Torque-angle characteristics of the stepper motor.

SWITCHED RELUCTANCE MOTOR:
Construction, operating performance, Type of converter and speed control, applications.

BRUSHLESS DC MACHINES:
Construction and working principle, Equivalent magnetic circuit, Type of converter and speed control, Comparison between the axial and radial permanent magnet motors, applications.

CONDITION MONITORING OF ELECTRICAL MACHINES:
Concept of condition monitoring, benefit of condition monitoring, Fault detection & diagnosis techniques for Transformer and Induction motor, recent trends in condition monitoring.

DOUBLE FED INDUCTION MACHINES:
Comparison of DFIG with synchronous generator, constant voltage & frequency generation, reactive power compensation, Application of DFIG in wind power.

REFERENCE BOOKS:

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NETWORK MODELING:-

SHORT CIRCUIT ANALYSIS:-
SCA of multi node system using bus impedance matrix, Z-bus building algorithm, asymmetrical fault analysis using Z-bus, development of voltage and current equations under asymmetrical fault using symmetrical components.

LOAD FORECASTING TECHNIQUES:-
Methods of Load Forecasting

CONTINGENCY ANALYSIS:-
Power systems State estimation and various techniques like LSET & WLSET, The line power flow state estimation.

COMPUTER CONTROL OF POWER SYSTEM:-
Need of real time and computer control of power system, Operating states of power system, SCADA & Energy Management Centers, Smart Grid.

REFERENCE BOOKS:

Amended by the BoS and approved by the Academic Council at its 9th Meeting held on 14.04.2018
MATLAB FOR SIGNAL PROCESSING:

SAMPLED SIGNALS AND DIGITAL PROCESSING:

RANDOM SIGNALS:

TEMPORAL AND SPATIAL SIGNAL PROCESSING:

DISCRETE-TIME FILTERS:

REFERENCE BOOKS
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Unit I
Conventional Energy Sources-Global & National Energy Scenarios, Environmental Aspects and Global Warming,

Unit II
Classification of Renewable Energy Sources, Solar Technology and Applications, Photo Electrochemical Conversion of Solar Energy,

Unit III
Mini, Micro and Pico Hydro Plants, Ocean Wave, Tidal and Ocean Thermal Energy Conversion

Unit IV
Magneto Hydrodynamic Power Generation, Environmental Aspects and Efficiency enhancement, Liquid Metal MHD,

Unit V
Thermoelectric and Thermionic Converters.

Books:
2. T. Abbasi & S.A. Abbasi Renewable Energy Sources Their Impact On Global Warming
3. Rowe Thermoelectrics And Its Energy Harvesting, 2 Volume Set
4. Research Papers And Internet Search
## RENEWABLE ENERGY POWER SYSTEMS:
Development of renewable energy systems—solar thermal, solar PV, wind, small hydropower, bio-fuel & bio-waste, gassifiers, tidal, geo-thermal, their merits & demerits, reliability, need of cogeneration.

## HYBRID CO-GENERATION:
Solar PV, wind, SHP, DG and their combinations; PV, wind and hydro based stand-alone hybrid power systems, control of hybrid power systems with and without grid connection, system planning, operating features and performance, zero-energy buildings.
Wind and DG stand-alone hybrid power systems, control of hybrid power systems with and without grid connection.

## POWER ELECTRONIC SYSTEMS:
Grid interactive systems, grid tied systems, inverters, FACTS and application of its devices, smart homes, power management and smart grid, intelligent metering.

## ENERGY STORAGE SYSTEMS:
Energy storage systems, different battery systems and battery charging, system planning, operating features and performance calculations, selected topics.

## REFERENCES:
FACTS AND PRELIMINARIES:
FACTS concept and general system considerations - power flow in AC
System - definitions on FACTS - basic types of FACTS controllers. Converters for Static Compensation - Three phase converters and standard modulation strategies (Programmed Harmonic Elimination and SPWM) - GTO Inverters - Multi-Pulse Converters and Interface Magnetics - Transformer Connections for 12, 24 and 48 pulse operation - Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM) - Multi-level inverters of Cascade Type and their modulation - Current Control of Inverters.

STATIC SHUNT AND SERIES COMPENSATORS:

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.

POWER QUALITY AND INTRODUCTION TO CUSTOM POWER DEVICES:

REFERENCE BOOKS
1. K. R. Padiyar, FACTS Controllers in Power Transmission and Distribution, New Age International
INTRODUCTION:
Introduction to AC and DC Transmission – application of DC Transmission – description of DC transmission – DC system components and their functions – modern trends in DC Transmission

CONVERTER:
Pulse Number – Converter configuration – analysis of Graetz circuit – converter bridge characteristics – characteristics of 12 Pulse converter

HVDC CONTROLLERS:
General principle of DC link control – converter control characteristics – system control hierarchy – firing angle control – current and extinction angle control – Dc link power control – high level controllers

FILTERS
Introduction to harmonics – generation of harmonics – design of AC filters – DC filters – carrier frequency and RI noise

PROTECTION:

REFERENCE BOOKS
GENERATION OF HIGH DIRECT VOLTAGES:
Simple rectifier circuits, cascaded circuits: Cockroft-Walton circuit, Electrostatic generators.

GENERATION OF HIGH ALTERNATING VOLTAGES:
Testing transformers, cascaded transformers, resonant transformers.

GENERATION OF IMPULSE VOLTAGES AND CURRENTS:
Single stage and multistage impulse generator circuits, Tripping and control of impulse generators.

HIGH VOLTAGE MEASUREMENT TECHNIQUES:
Peak Voltage, Measurement by spark gaps; Chubb-Fortescue Method; potential dividers; impulse voltage and current measurements, Layout and clearances of High Voltage Lab.

REFERENCES:
3. Craggs & Meek High Voltage Laboratory Technique, Butterworths, London,
4. IEEE Transactions on Dielectrics and Insulation
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**TRANSDUCER INSTRUMENTATION:**
Primary sensors, voltage and current generating analogue Transducers, variable parameter analogue Transducers, Frequency generating and Digital Transducers, transducer selection factors.

**TELEMETRY SYSTEM:**

**DEVICES FOR INSTRUMENTATION**
Amplifiers, Multiplexes, Timers, Sample and Hold, Isolators, Signal Converters, ADC & DAC, Instrumentation & Signal Processing, drive related signals and their instrumentation and conditioning.

**DATA ACQUISITION SYSTEM**
basic structure, data acquisition of drive related variables.

**REFERENCE BOOKS:**
### Subject Details

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**MEASUREMENT:**

**CONTROL:**
Transfer function, Transfer function for Mechanical System Control System Components, Signal flow Graph with Problems, Transient response of feedback control systems, Transient response of second order system, Steady State response and steady state Error, Problems, Stability: Routh criterion, Polar plots and bode plots, Nyquist criterion,

**CONTROLLERS:**
Hydraulic and Pneumatic Controllers.

**REFERENCES:**
1. D. Patranabis Principle of Industrial Instrumentation, (TMH)
2. B.C. Kuo Automatic Control System
INTRODUCTION
Characterisation of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Nonlinear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.

NON-LINEAR LOADS
Single phase static and rotating AC/DC converters, Three phase static AC/DC converters, Battery chargers, Arc furnaces, Fluorescent lighting, pulse modulated devices, Adjustable speed drives.

MEASUREMENT AND ANALYSIS METHODS

ANALYSIS AND CONVENTIONAL MITIGATION METHODS
Analysis of power outages, Analysis of unbalance: Symmetrical components of phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion: On-line extraction of fundamental sequence components from measured samples – Harmonic indices – Analysis of voltage sag: Detroit Edison sag score, Voltage sag energy, Voltage Sag Lost Energy Index (VSLEI)- Analysis of voltage flicker, Reduced duration and customer impact of outages, Classical load balancing problem: Open loop balancing, Closed loop balancing, current balancing, Harmonic reduction, Voltage sag reduction.

POWER QUALITY IMPROVEMENT

REFERENCE BOOKS
3. Power Quality - R.C. Duggan
5. Power electronic converter harmonics –Derek A. Paice
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REACTIVE ELEMENTS IN POWER ELECTRONIC SYSTEMS:
Design of inductor, Design of transformer, Capacitors for power electronic applications.

DC-TO-DC CONVERTERS:
Buck converter, Boost Converter, Buck-Boost Converter, Forward Converter, Push-Pull Converter, Fly-back Converter, Half and full bridge Converter.

CLOSED LOOP CONTROL OF POWER CONVERTERS:

CLASSIFICATION OF RESONANT CONVERTERS:
Basic resonant circuit concepts, Load resonant converters, Resonant Switch Converters, Zero Voltage Switching.

DESIGN OF FEEDBACK COMPENSATORS:
Unity power factor rectifiers, Resistor emulation principle and applications to rectifiers.

REFERENCE BOOKS:
Objective:
To assess the debating capability of the student to present a technical topic. Also to impart training to a student to face audience and present his ideas and thus creating in him self-esteem and courage that are essential for an engineer.

Individual students are required to choose a topic of their interest from power electronics and drives related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in power electronics) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.
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**Objective:**
To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

The project work can be a design project/experimental project and/or computer simulation project on any of the topics in power electronics/drives related topics. The project work is allotted individually on different topics. The students shall be encouraged to do their project work in the parent institute itself. If found essential, they may be permitted to continue their project outside the parent institute. Department will constitute an Evaluation Committee to review the project work. The Evaluation committee will consist of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members.

The student is required to undertake the master research project phase 1 during the third semester and the same is continued in the 4th semester (Phase 2). Phase 1 consist of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4th semester. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members.

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