M.Tech: Power Electronics & Drives

Course Structure

I Year, Semester – I

S.No	Course Code	Course Category	Course Title	Hours per week			Total Contact Hours	Credits
				Lecture	Tutorial	Practical		
1	20211T01	PCC	Mathematical Modeling of Machines	3	-	-	3	3
2	20211T02	PCC	Analysis of power Electronic Converters	3	-	-	3	3
3	20211T03	PCC	Power Electronic Control of DC Drives	3	-	-	3	3
4	20211T04	PCC	Digital Signal processing	3	-	-	3	3
5	20211T05	HSMC	Research Methodology & IPR	3	-	-	3	3
6	20211L06	PCC	Simulation of Electrical Machines and Converters	-	-	6	6	3
Total number of credits								**18**

I Year, Semester – II

S.No	Course Code	Course Category	Course Title	Hours per week			Total Contact Hours	Credits
				Lecture	Tutorial	Practical		
1	20212T01	PCC	Power Electronic Control of AC Drives	3	-	-	3	3
2	20212T02	PCC	Advanced Power Electronic Converters	3	-	-	3	3
3	20212T03	PEC	RES/SEM/DCS	3	-	-	3	3
4	20212T04	PEC	SG/FACTS/Opt Tech	3	-	-	3	3
5	20212L05	PCC	Electric Drives Lab	-	-	6	6	3
6	20212P06	PROJ	Mini Project with Seminar	-	-	6	6	3
Total number of credits								**18**

II Year, Semester – I

S.No	Course Code	Course Category	Course Title	Hours per week			Total Contact Hours	Credits
				Lecture	Tutorial	Practical		
1	20213T01	PCC	Digital Control of Drives	3	-	-	3	3
2	20213T02	PEC	ES/VLSI/IP	3	-	-	3	3
3	20213T03	PROJ	Phase – I Dissertation	-	-	-	20	10
Total number of credits								**16**

II Year, Semester – II

S.No	Course Code	Course Category	Course Title	Hours per week			Total Contact Hours	Credits
				Lecture	Tutorial	Practical		
1	20214P01	PROJ	Phase – II Dissertation	-	-	-	32	16
Total number of credits								**16**

M.Tech I Semester

L	T	P	C
3	0	0	3

20211T01 MATHEMATICAL MODELING OF MACHINES

Unit-I

Basic Concepts of Rotating Machines-Calculation of air gap mmf and per phase machine inductance using physical machine data; Voltage and torque equation of dc machine.

UNIT – 2: Basic concepts of Modeling

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

UNIT – 3: DC Machine Modeling

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

UNIT- 4: Reference frame theory& Modeling of single phase Induction Machines

Linear transformation-Phase transformation - three phase to two phase transformation (abc to αβ0) and two phase to three phase transformation αβ0 to abc - -Power equivalence-Mathematical modeling of single phase induction machines.

UNIT – 5: Modeling of three phase Induction Machine

Generalized model in arbitrary reference frame-Electromagnetic torque-Derivation of commonly used Induction machine models- Stator reference frame model-Rotor reference frame model-Synchronously rotating reference frame model-state space model with flux linkages as variables

UNIT –6: Modeling of Synchronous Machine& Special machines

Synchronous machine inductances –voltage equations in the rotor's dq0 reference rame electromagnetic torque-current in terms of flux linkages-three synchronous machine model modeling of PM Synchronous motor, modeling of BLDC motor, modeling of Switched Reluctance motor

Reference Books:

1. Electric Motor Drives - Modeling, Analysis& control -R.Krishnan- Pearson Publications-1st edition -2002

2. P.S.Bhimbra," Generalised theory of Electrical Machines"-Fifth edition,Khanna publishers.

M.Tech I Semester

L	T	P	C
3	0	0	3

20211T02 ANALYSIS OF POWER ELECTRONIC CONVERTERS

UNIT –1: AC-DC converters
Single phase Half controlled and Fully controlled Converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-Power factor improvements-Extinction angle control-symmetrical angle control-PWM single phase sinusoidal PWM-Single phase series converters- numerical problems. Three Phase ac-dc Converters- Half controlled and fully controlled Converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and continuous load current-three phase dual converters-Power factor improvements-three phase PWM-twelve pulse converters- numerical problems

UNIT-2:DC-DC Converters

Analysis and design of DC to DC converters. Control of DC-DC converters: Buck converters, Boost converters, Buck-Boost converters, Cuk converters.

UNIT –3: PWM Inverters
Principle of operation-Voltage control of single phase inverters - sinusoidal PWM – modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation – numerical problems. Voltage Control of Three-Phase Inverters- Sinusoidal PWM- 60 ^{0} PWM- Third Harmonic PWM- Space Vector Modulation-Comparison of PWM Techniques-current source inverters-Variable dc link inverter - numerical problems

UNIT 4: Multi level inverters
Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel
Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter- Flying-Capacitors Multilevel Inverter- Principle of Operation, Features of Flying- Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation-Features of Cascaded Inverter- Switching Device Currents-DC-Link Capacitor Voltage Balancing- Features of Multilevel Inverters- Comparisons of Multilevel Converters

UNIT 5 -
AC to AC power conversion using voltage regulators. Choppers and cyclo-converters. Consideration of harmonics, introduction to Matrix converters.

UNIT-6 : AC voltage Controllers
Single Phase AC Voltage Controllers with RL and RLE loads-ac voltage controller's with PWM control-Effects of source and load inductances –synchronous tap changers – Applicationnumerical problems Three Phase AC Voltage controllers-Analysis of Controllers with star and delta connected resistive, resistive –inductive loads-Effects of source and load inductances–Application - numerical problems.

Reference books:
1. Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First Indian Reprint- 2008
2. Power Electronics- Ned Mohan, Tore M.Undelan and William P.Robbins –John Wiley & Sons -2nd Edition.
3. Modern power Electronics and AC Drives – B.K.Bose

M.Tech I Semester

L	T	P	C
3	0	0	3

20211T03 POWER ELECTRONIC CONTROL OF DC DRIVES

UNIT-I Dynamics of Electric Drives: Fundamentals of torque equation. Speed torque convention and multi-quadrant operation, components of load torques.

UNIT-II Classification of load torques steady state stability. Load equation, Speed control and drive classification. Close loop control of drives.

UNIT-III Introduction on single phase convertor fed DC motor drive:
Single phase full-convertor and half-convertor fed dc drives for continuous and discontinuous mode of operation. Four quadrant operation of drive using dual convertor.

UNIT-IV Three phase AC-DC convertor fed DC motor drive:
Three phase full-convertor and half-convertor fed dc drives for continuous and discontinuous mode of operation. Four quadrant operation of drive using three phase dual convertor. Pulsating
torque

UNIT-V Modeling of AC-DC convertor fed DC drive components & design of controller:
Transfer function of Dc motor and load, convertor, current and speed controllers, current and speed feedback elements. Design of current controller and speed controller. Closed loop two quadrant DC motor drive, closed loop four quadrant DC motor drive, introduction to simulation of DC motor drive.

UNIT-VI DC-DC convertor fed DC motor drive:
Four quadrant DC-DC convertor fed dc motor drive, steady state analysis of DC-DC convertor dc motor drive, pulsating torques. Closed loop operation of DC-DC convertor fed dc motor **drive-**Design of current controller, design of speed controller, modeling of current and speed controller, introduction to simulation of speed controlled dc motor drive.

Reference Books:
1. Electrical Motor Drives Modeling, Analysis and Control – R. Krishna, Prentice Hall India.
2. Power Semiconductor Controlled Drives – G.K. Dubey.Prentice Hall India.
3. Power Electronics and Motor control – Shepherd, Hulley, Liang-II Edition, Cambridge University Press.
4. Power electronic circuits, devices and applications – M.H.Rashid – PHI.

M.Tech I Semester

L	T	P	C
3	0	0	3

20211T04 DIGITAL SIGNAL PROCESSING

UNIT-I Discrete Time Signals and Systems: Introduction to Digital signal processing, discrete time Signals, Discrete time systems, Analysis of Linear Time-Invariant Systems, Convolution, Causality and Stability.

UNIT-II The Z- Transform: Definition, Properties of Z-Transform, Inverse z Transform, Computation of Frequency Response, Solution of linear constant coefficient difference equations using Z Transforms

UNIT-III The Discrete Fourier Transform (DFT): Introduction to DFT, Properties of the DFT, Circular Convolution, , overlap add method, overlap save method, Relationship of DFT to other Transforms. Radix-2 Decimation-In-Time (DIT) and Decimation-In-Frequency (DIF) FFT Algorithms, Inverse FFT.

UNIT-IV Design of IIR Digital Filter : Design procedure for Analog Butterworth and Chebyshev filters, Design of IIR Digital Filters using Bilinear Transformation, Analog Design using Digital Filters, Design of Digital Filters using Digital to Digital Transformation, Impulse Invariant Design.

UNIT-V Design of FIR Digital Filters: Introduction to FIR Filters, Design of Linear phase FIR Digital Filters using Windows(Rectangular, Bartlett, Blackman, Hamming and Hanning windows) and Frequency Sampling Method. Realization of Discrete time systems,: Realization of IIR and FIR systems-Direct, Cascade, Parallel, Ladder realizations.

UNIT-VI Multirate Digital Signal Processing :Introduction, Decimation and Interpolation by integer factor, Sampling rate conversion by Rational number, Multistage approach to sampling rate Conversion, Applications of Multirate Signal processing.

Reference Books:

1. A.V. Oppenheim and R. W. Schafer, “Discrete Time Signal Processing”, Prentice Hall, 1989.
2. J. G. Proakis and D.G. Manolakis, “Digital Signal Processing: Principles, Algorithms And
Applications”, Prentice Hall, 1997.

M.Tech I Semester

L	T	P	C
3	0	0	3

20211T05 RESEARCH METHODOLOGY & IPR

Unit 1:

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit 2:

Effective literature studies approaches, analysis Plagiarism, Research ethics

Unit 3:

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 4:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5:

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit 6:

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Reference Books:

1.T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008.
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”

M.Tech I Semester

L	T	P	C
0	0	6	3

20211L06 SIMULATION OF ELECTRICAL MACHINES AND CONVERTERS LAB

LIST OF EXPERIMENTS

1. Modelling of DC Machine.
2. Modelling of Induction Machine along Stationary Reference frame
3. Modelling of Induction Machine along synchronously rotating Reference frame
4. Modelling of Induction Machine along Rotor Reference frame
5. Modelling of Synchronous Machine.
6. Simulation of single phase half controlled converter with Rand R L load
7. Simulation of single phase Full converter with Rand R L load
8. Simulation of Three phase half controlled converter with Rand R L load
9. Simulation of Three phase Full converter with Rand R L load
10. Simulation of single phase AC Voltage controller with R and R L Load.
11. Simulation of Single phase Cyclo Converter with R and R L Load.
12. Simulation of Chopper with R and R L Load.

M.Tech II Semester

L	T	P	C
3	0	0	3

20212T01 POWER ELECTRONIC CONTROL OF AC DRIVES

UNIT-I: 3-phase induction motor drives – Part 1

Analysis of IM fed from non-sinusoidal supply, harmonic equivalent circuit, transient analysis –starting and plugging; variable frequency control, torque-slip relation, starting torque and braking torque, closed-loop VSI fed IM drive. Slip-ring IM control, closed-loop speed control with static rotor resistance, closed-loop speed control by using slip power recovery scheme.

UNIT-II: 3-phase induction motor drives – Part 2

Concept of space vector, vector control of IM: direct or feed-back vector control, flux vector estimation, indirect or feed forward vector control, vector control of line side PWM converter, stator flux oriented vector control, vector control of converter fed inverter drive.

UNIT-III: Synchronous motor and BLDC motor drives

Variable frequency control of synchronous motor, closed-loop control of inverter fed synchronous motor drive. Permanent magnet synchronous motor drive. BLDC motor drives, VSI fed BLDC motor drives, back emf, phase current and torque waveforms, control of BLDC motors with sensors, sensor-less control of BLDC motors

UNIT-IV: Traction drives

Motors employed in railway traction and road-vehicles, control of railway traction dc motors using ac-dc converters, control of railway traction ac motors using ac-dc and dc-ac converters, power electronic control circuits of electric vehicles and hybrid electric vehicles

UNIT-V: Switched reluctance and stepper motor drives

Switched reluctance motor operation and control: modes of operation, converter circuits closed loop speed control. Stepper motor characteristics drive circuits for uni-polar and bipolar stepper motors.

UNIT VI: Industrial Drives-Digital Control of Electric Drives. Stepper motor.Servo motor and their Applications

Reference Books

1. “Electric motor drives, modeling, analysis and control”, R. Krishnan, PHI Publishers
2. “Power Electronics: Converters,Application and design” ,Mohan, Undeland and Robbins, Wiley Publications.
3. “Urban transport and hybrid electric vehicles”, Edited by SerefSoylu, Published online, 20 Aug 2010. Available:http://www.intechopen.com/books/urban-transport-and-
4. “Power semiconductor drives”, G. K. Dubey, Printice Hall International
5. “Fundamentals of electric drives”, G. K. Dubey, Narosa Publishing House

M.Tech II Semester

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3	0	0	3

20212T02 ADVANCED POWER ELECTRONIC CONVERTERS

UNIT-I: Non-isolated switch mode converters:

Control of DC-DC converters, Buck converters, Boost converters, Buck-Boost converter, CUK Converter, Converter realization with nonideal components.

UNIT-II: Resonant converters:

Basic resonant circuit concepts, series resonant circuits, parallel resonant circuits, zero current switching Quasi-resonant buck converter, zero current switching Quasi-resonant boost converter, zero voltage switching Quasi-resonant buck converter, zero voltage switching Quasi-resonant boost converter

UNIT-III: Isolated switch-mode converters:

Forwarded converter, fly back converter, Push-pull converter, half-bridge converter, full bridge converter

UNIT-IV: Control schemes of switching converters:

Voltage-mode control, Current-mode control, control scheme for resonant converters, proportional integral controller. Magnetic design consideration: Transformers design, DC inductor and capacitor design.

UNIT V: Three phase utility interphases and control-Buck, Boost, Buck-Boost SMPS Topologies.

UNIT-VI: Modeling& Control design based on linearization:

Formulation of averaged models for buck and boost converters average circuits models, small –signal analysis and linearization. Control design based on linearization: Transfer function of converters, control design, large signal issues in voltage-mode & current-mode control.

Reference Books

1. Power Electronics – IssaBataresh, Jhonwilley publications,2004
2. Elements of Power Electronics – Philip T. Krein, Oxford University press.
3. Power Electronics: converters Applications & Design – Mohan, Undeland, Robbins-Wiley publications

L	T	P	C
3	0	0	3

M.Tech II Semester

20212T03RENEWABLE ENERGY SYSTEMS

UNIT-I

Need for Distributed generation.Renewable sources in distributed generation and current scenario in Distributed Generation

UNIT-II

Solar Energy - Availability - Solar radiation data and measurement - Estimation of average solar radiation - Solar water heater types - Heat balance – Flat plate collector efficiency – Efficiency of heat removal - Thermo siphon flow calculation - Forced circulation calculation – Evacuated collectors - Basics of solar concentrators Solar Energy Applications - Solar air heaters – Solar Chimney - Crop driers - Passive solar system - Active solar systems - Water desalination - Output from solar still – Principle of solar ponds.

UNIT-III

Wind Energy – Nature of wind – Characteristics – Variation with height and time – Power in wind –Aerodynamics of Wind turbine – Momentum theory – Basics of aerodynamics – Aero foils and their characteristics – HAWT – Blade element theory – Prandtl's lifting line theory (prescribed wake analysis) VAWT aerodynamics – Wind turbine loads – Aerodynamic loads in steady operation – Yawed operation and tower shadow. Wind Energy Conversion System – Siting – Rotor selection – Annual energy output – Horizontal axis wind turbine (HAWT) – Vertical axis wind turbine (VAWT) – Rotor design considerations – Number of blades – Solidity - Blade profile – Upwind/Downwind – Yaw system – Tower – Braking system - Synchronous and asynchronous generators and loads – Integration of wind energy converters to electrical networks – Inverters – Control system – Requirement and strategies – Noise Applications of wind energy

UNIT-IV

Biomass energy - Bio fuel classification – Examples of thermo chemical, Pyrolysis, biochemical and agrochemical systems – Energy farming – Direct combustion for heat – Process heat and electricity – Ethanol production and use – Anaerobic digqaestion for biogas – Different digesters – Digester sizing – Applications of Biogas - Operation with I.C.Engine

UNIT-V

Ocean Energy - OTEC Principle - Lambert's law of absorption - Open cycle and closed cycle - heat exchanger calculations – Major problems and operational experience. Tidal Power - Principles of power generation - components of power plant – Single and two basin systems – Turbines for tidal power - Estimation of energy – Maximum and minimum power ranges – tidal powerhouse. Wave Energy – Concept of energy and power from waves – Wave characteristics –period and wave velocities - Different wave energy conservation devices (Saltor duck, oscillating water column and dolphin types) – operational experience.

UNIT-VI

Geothermal Energy - Classification- Fundamentals of geophysics - Dry rock and hot aquifer energy analysis - Estimation of thermal power - Extraction techniques - Prime movers.

Reference Books:

1. Renewable Energy Resources / John Twidell and Tony Weir / E &F.N.Spon
2. Renewable Energy Resources Basic Principles and Applications / G.N.Tiwari and M.K.Ghosal / Narosa
3. Solar Energy - Principles of thermal collection and storage/ S.P. Sukhatme / TMH
4. Solar Energy Thermal Processes,/Duffie& Beckman
5. Solar Heating and Cooling / Kreith&Kreider, CRC press.
6. Wind Energy Handbook / Tony Burton, David Sharpe, Nick Jenkins and Ervin Bossanyi /WileyWind Electrical Systems / S.N.Bhadra, D.Kastha and S.Banerjee / Oxford
7. Biogas Technology - A Practical Hand Book / K.Khendelwal& S.S. Mahdi / McGraw-Hill.

M.Tech II Semester

L	T	P	C
3	0	0	3

20212T03 SPECIAL ELECTRICAL MACHINES

UNIT I

Switched Reluctance Motor

Principle of operation, design of stator and rotor pole arc, power converter for switched reluctance motor. Stepper Motors Construction, principle of operation, theory of torque production, hybrid stepping motor, variable reluctance stepping motor.

UNIT II

Brushless DC Motor

Construction, principle of operation, theory of brushless DC motor as variable speed synchronous motor.

UNIT III

Linear Induction Motor

Construction, principle of operation, application of linear induction drive for electric traction. Permanent Magnet Motors , Hysteresis loop, permanent magnet DC Motors, equivalent circuit, electrically commutated DC Motor.

UNIT IV

Control of special machines-I

Stepper motors (open loop control, closed loop control). Characteristics of stepper motor in open–loop drive. Comparison of open loop and closed loop systems.

UNIT V

Control of special machines-II

Control of switched reluctance motor for fraction type load. Control of brushless dc motor, rotor position sensing and switching logic for brushless dc motor.

UNIT VI

Electric Motors for traction drives

AC motors, DC motors, single sided linear induction motor for traction drives, comparison of AC and DC traction.

Text Books:

1. Brushless Permanent magnet and reluctance motor drives, Clarenden press, T.J.E. Miller, 1989, Oxford.
2. Special electrical Machines, K.VenkataRatnam, University press, 2009, New Delhi.

M.Tech II Semester

L	T	P	C
3	0	0	3

20212T03 DIGITAL CONTROL SYSTEMS

UNIT – I:

Introduction and signal processing

Introduction to analog and digital control systems – Advantages of digital systems – Typical examples – Signals and processing – Sample and hold devices – Sampling theorem and data reconstruction – Frequency domain characteristics of zero order hold.

UNIT–II:

z–transformations

z–Transforms – Theorems – Finding inverse z–transforms – Formulation of difference equations and solving – Block diagram representation – Pulse transfer functions and finding open loop and closed loop responses.

UNIT–III:

State space analysis and the concepts of Controllability and observability

State space representation of discrete time systems – State transition matrix and methods of evaluation – Discretization of continuous – Time state equations – Concepts of controllability and observability – Tests(without proof).

UNIT – IV:

Stability analysis

Mapping between the s–Plane and the z–Plane – Primary strips and Complementary strips – Stability criterion – Modified Routh's stability criterion and Jury's stability test.

UNIT – V:

Design of discrete–time control systems by conventional methods

Transient and steady state specifications – Design using frequency response in the w–plane for lag and lead compensators – Root locus technique in the z–plane.

UNIT – VI:

State feedback controllers:

Design of state feedback controller through pole placement – Necessary and sufficient conditions – Ackerman's formula.

Text Book:

1. Discrete–Time Control systems – K. Ogata, Pearson Education/PHI, 2nd Edition.
2. Digital Control and State Variable Methods by M.Gopal, TMH, 4th Edition.

Reference Books:

1. Digital Control Systems, Kuo, Oxford University Press, 2nd Edition, 2003

M.Tech II Semester

L	T	P	C
3	0	0	3

20212T04 SMART GRIDS

UNIT-I Introduction to Smart Grid, Evolution of Electric Grid. Concept of Smart Grid, Definitions, Need of Smart Grid.Concept of Robust &Self-Healing Grid, Present development & International policies in Smart Grid

UNIT-II Introduction to Smart Meters, Real Time Prizing, Smart Appliances. Automatic Meter Reading (AMR).Outage Management System (OMS).Plug in Hybrid Electric Vehicles(PHEV).Vehicle to Grid, Smart Sensors. Home & Building Automation, Smart Substations, Substation Automation, Feeder Automation

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

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

UNIT V Power Quality & EMC in Smart Grid.Power Quality issues of Grid connected Renewable Energy Sources. Power Quality Conditioners for Smart Grid.Web based Power Quality monitoring, Power Quality Audit

UNIT VI Advanced Metering Infrastructure (AMI), Home Area Network (HAN). Neighbourhood Area Network (NAN), Wide Area Network (WAN).Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication.Wireless Mesh Network. Basics of CLOUD Computing &Cyber Security for Smart Grid. Broadband over Power line (BPL). IP based protocols

Reference Books

1. Ali Keyhani, “Design of smart power grid renewable energy systems”, Wiley IEEE,2011.
2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC
Press, 2009.

3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, "Smart Grid: Technology and Applications", Wiley 2012.

4. Stuart Borlas'e, "Smart Grid:Infrastructure, Technology and solutions "CRC Press.

5. A.G.Phadke , "Synchronized Phasor Measurement and their Applications",Springer.

M.Tech II Semester

L	T	P	C
3	0	0	3

20212T04 FLEXIBLE AC TRANSMISSION SYSTEMS

UNIT-I

Reactive power flow control in Power Systems – Control of dynamic power unbalances in Power System. Power flow control -Constraints of maximum transmission line loading –Benefits of FACTS Transmission line compensation. Uncompensated line -Shunt compensation - Series compensation –Phase angle control. Reactive power compensation. Shunt and Series compensation principles – Reactive compensation at transmission and distribution level

UNIT-2

Static versus passive VAR compensator, Static shunt compensators: SVC and STATCOM - Operation and control of TSC, TCR and STATCOM -Compensator control. Comparison between SVC and STATCOM.

UNIT-3

Static series compensation: TSSC, SSSC -Static voltage and phase angle regulators – TCVR and TCPAR Operation and Control –Applications, Static series compensation – GCSC, TSSC, TCSC and Static synchronous series compensators and their Control.

UNIT -4

SSR and its damping Unified Power Flow Controller: Circuit Arrangement, Operation and control of UPF. Basic Principle of P and Q control- Independent real and reactive power flow control- Applications.

UNIT-5

Introduction to interline power flow controller. Modeling and analysis of FACTS Controllers – Simulation of FACTS controllers Power quality problems in distribution systems, harmonics. Loads that create harmonics, modeling, harmonic propagation, series and parallel resonances, mitigation of harmonics, passive filters, active filtering – shunt , series and hybrid and their control.

UNIT-6

Voltage swells, sags, flicker, unbalance and mitigation of these problems by power line conditioners- IEEE standards on power quality.

Reference Books:

1. K R Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New

AgeInternationalPublishers, 2007.

2. N.G. Hingorani, L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.

M.Tech II Semester

L	T	P	C
3	0	0	3

20212T04 OPTIMIZATION TECHNIQUES

UNIT – 1 Introduction and Classical Optimization Techniques:

Statement of an Optimization problem – design vector – design constraints – constraint surface –objective function – objective function surfaces – classification of Optimization problems. Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints. Solution by method of Lagrange multipliers – multivariable Optimization with inequality constraints – Kuhn – Tucker conditions.

UNIT – 2: Linear Programming

Standard form of a linear programming problem – geometry of linear programming problems –definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm - Duality in Linear Programming – Dual Simplex method.

UNIT – 3:Nonlinear Programming 1

Unconstrained cases - One – dimensional minimization methods: Classification, Fibonacci method and Quadratic interpolation method – Uni variate method, Powell's method and steepest descent method.

UNIT- 4 : Nonlinear Programming 2

Constrained cases - Characteristics of a constrained problem, Classification, Basic approach of Penalty Function method; Basic approaches of Interior and Exterior penalty function methods. Introduction to convex Programming Problem.

UNIT – 5:

Introduction to Evolutionary Methods:

Evolutionary programming methods - Introduction to Genetic Algorithms (GA)– Control parameters –Number of generation, population size, selection, reproduction, crossover and mutation – Operator selection criteria – Simple mapping of objective function to fitness function

– constraints – Genetic algorithm steps – Stopping criteria –Simple examples.

UNIT – 6:

Introduction to Swarm Intelligence Systems:

Swarm intelligence programming methods - Basic Partial Swarm Optimization – Method – Characteristic features of PSO procedure of the global version – Parameters of PSO (Simple PSO
algorithm – Operators selection criteria – Fitness function constraints) – Comparison with other evolutionary techniques – Engineering applications of PSO.

Reference Books:

1. Soft Computing with Matlab Programming by N.P.Padhy&S.P.Simson, Oxford University Press – 2015
2. Linear Programming by G.Hadley.,Narosa Publishers.

M.Tech II Semester

L	T	P	C
0	0	6	3

20212L05 ELECTRIC DRIVES LAB

List of experiments

1. Analysis and speed control of DC motor drive using 3-phase full Converter.
2. Analysis of a four quadrant Chopper feeding DC motor.
3. Analysis of a 3-phase A.C. Voltage controller fed to R & RL - load.
4. Analysis of Buck, Boost, Buck-Boost DC-DC converters.
5. Analysis of Single Phase IGBT based PWM Inverter connected to R & R-L load
6. Analysis of 3-phase IGBT based PWM Inverterfeeding R & R-L load.
7. Analysis and speed control of 3 phase slip ring Induction motor by Static Rotor Resistance controller.
8. Analysis of DSP based V/F Control of 3 phase Induction motor.
9. Regenerative/ Dynamic breaking operatation for DC motor study using software.
10. PC/PLC based AC/DC motor control operation.

M.Tech III Semester

L	T	P	C
3	0	0	3

20213T01 DIGITAL CONTROL OF DRIVES

UNIT-1

Review of numerical methods. Application of numerical methods to solve transients in D.C. Switched R, L, R-L, R-C and R-L-C circuits. Extension to AC circuits.

UNIT-2

Modelling of diode in simulation. Diode with R, R-L, R-C and R-L-C load with AC supply. Modelling of SCR, TRIAC, IGBT and Power Transistors in simulation. Application of numerical methods to R, L, C circuits with power electronic switches. Simulation of gate/base drive circuits, simulation of snubber circuits.

UNIT-3

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

UNIT-4

Simulation of single phase and three phase uncontrolled and controlled (SCR) rectifiers. Converters with self-commutated devices- simulation of power factor correction schemes.

UNIT-5

Simulation of converter fed DC motor drives. Simulation of thyristor choppers with voltage. Current and load commutation schemes. Simulation of chopper fed DC motor.

UNIT-6

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

Reference Books:

1. Simulink Reference Manual, Math works, USA

M.Tech III Semester

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20213T02 EMBEDDED SYSTEMS

UNIT-I

INTRODUCTION: Embedded system-Definition, history of embedded systems, classification of embedded systems, major application areas of embedded systems, purpose of embedded systems, the typical embedded system-core of the embedded system, Memory, Sensors and Actuators, Communication Interface, Embedded firmware, Characteristics of an embedded system, Quality attributes of embedded systems, Application-specific and Domain-Specific examples of an embedded system.

UNIT-II

EMBEDDED HARDWARE DESIGN: Analog and digital electronic components, I/O types and examples, Serial communication devices, Parallel device ports, Wireless devices, Timer and counting devices, Watchdog timer, Real time clock.

UNIT-III

EMBEDDED FIRMWARE DESIGN: Embedded Firmware design approaches, Embedded Firmware development languages, ISR concept, Interrupt sources, Interrupt servicing mechanism, Multiple interrupts, DMA, Device driver programming, Concepts of C versus Embedded C and Compiler versus Cross-compiler.

UNIT-IV

REAL TIME OPERATING SYSTEM: Operating system basics, Types of operating systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling, Task communication, Task synchronisation, Device Drivers.

HARDWARE SOFTWARE CO-DESIGN: Fundamental Issues in Hardware Software Co-Design, Computational models in embedded design, Hardware software Trade-offs, Integration of Hardware and Firmware, ICE.

UNIT-V

EMBEDDED SYSTEM DEVELOPMENT: The integrated development environment, Types of files generated on cross-compilation, Deassembler/ Decompiler, Simulators, Emulators and Debugging, Target hardware debugging, Boundary Scan, Embedded Software development process and tools.

UNIT-VI

EMBEDDED SYSTEM IMPLEMENTATION AND TESTING: The main software utility tool, CAD and the hardware, Translation tools-Pre-processors, Interpreters, Compilers and Linkers, Debugging tools, Quality assurance and testing of the design, Testing on host machine, Simulators, Laboratory Tools.

Text Books:

1. Embedded Systems Architecture- By Tammy Noergaard, Elsevier Publications, 2013.

2. Embedded Systems-By Shibu.K.V-Tata McGraw Hill Education Private Limited, 2013.

References:

1. Embedded System Design, Frank Vahid, Tony Givargis, John Wiley Publications, 2013.

2. Embedded Systems-Lyla B.Das-Pearson Publications, 2013.

M.Tech III Semester

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20213T02 VLSI Design

UNIT-I:

Introduction and Basic Electrical Properties of MOS Circuits: Introduction to IC technology, Fabrication process: nMOS, pMOS and CMOS. Ids versus Vds Relationships, Aspects of MOS transistor Threshold Voltage, MOS transistor Trans, Output Conductance and Figure of Merit. nMOS Inverter, Pull-up to Pull-down Ratio for nMOS inverter driven by another nMOS inverter, and through one or more pass transistors. Alternative forms of pull-up, The CMOS Inverter, Latch-up in CMOS circuits, Bi-CMOS Inverter, Comparison between CMOS and
BiCMOS technology.

UNIT-II:

MOS and Bi-CMOS Circuit Design Processes: MOS Layers, Stick Diagrams, Design Rules and Layout, General observations on the Design rules, 2µm Double Metal, Double Poly, CMOS/BiCMOS rules, 1.2µm Double Metal,Double Poly CMOS rules, Layout Diagrams of NAND and NOR gates and CMOS inverter, Symbolic Diagrams-
Translation to Mask Form.

UNIT-III:

Basic Circuit Concepts: Sheet Resistance, Sheet Resistance concept applied to MOS transistors and Inverters, Area Capacitance of Layers, Standard unit of capacitance, Some area Capacitance Calculations, The Delay Unit, Inverter Delays, Driving large capacitive loads, Propagation Delays, Wiring Capacitances, Choice of layers.

Scaling of MOS Circuits: Scaling models and scaling factors, Scaling factors for device parameters, Limitations of scaling, Limits due to sub threshold currents, Limits on logic levels and supply voltage due to noise and current density. Switch logic, Gate logic.

UNIT-IV:

Chip Input and Output circuits: ESD Protection, Input Circuits, Output Circuits and L(di/dt) Noise, On-Chip clock Generation and Distribution.

Design for Testability: Fault types and Models, Controllability and Observability, Ad Hoc Testable Design Techniques, Scan Based Techniques and Built-In Self Test techniques.

UNIT-V:

FPGA Design: FPGA design flow, Basic FPGA architecture, FPGA Technologies, FPGA families- Altera Flex 8000FPGA, Altera Flex 10FPGA, Xilinx XC4000 series FPGA, Xilinx Spartan XL FPGA, Xilinx Spartan II FPGAs, Xilinx Vertex FPGA. Case studies: FPGA Implementation of Half adder and full adder.

Introduction to synthesis: Logic synthesis, RTL synthesis, High level Synthesis.

UNIT-VI:

Introduction to Low Power VLSI Design: Introduction to Deep submicron digital IC design**,** Low Power CMOS Logic Circuits: Over view of power consumption, Low – power design through voltage scaling, Estimation and optimisation of switching activity, Reduction of switching capacitance. Interconnect Design, Power Grid and Clock
Design.

Text Books:

1. Essentials of VLSI Circuits and Systems - Kamran Eshraghian, Douglas and A. Pucknell and Sholeh Eshraghian, Prentice-Hall of India Private Limited, 2005 Edition.
2. CMOS Digital Integrated Circuits Analysis and Design- Sung-Mo Kang, Yusuf Leblebici, Tata McGraw-Hill Education, 2003.

References:

1. Advanced Digital Design with the Verilog HDL, Michael D.Ciletti, Xilinx Design Series, Pearson Education
2. Analysis and Design of Digital Integrated Circuits in Deep submicron Technology, 3'rd edition, David Hodges.

M.Tech III Semester

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20213T02 IMAGE PROCESSING

UNIT-1

Introduction: Introduction to Image Processing, Fundamental steps in digital image processing, components of an image processing system, image sensing and acquisition, image sampling and quantization, some basic relationships between pixels, an introduction to the mathematical tools used in digital image processing.

Image Transforms: Need for image transforms, Discrete Fourier transform (DFT) of one variable, Extension to functions of two variables, some properties of the 2-D Discrete Fourier transform, Importance of Phase, Walsh Transform. Hadamard transform, Haar Transform, Slant transform, Discrete Cosine transform, KL Transform, SVD and Radon Transform, Comparison of different image transforms

UNIT-2

Intensity Transformations and Spatial Filtering: Background, Some basic intensity transformation functions, histogram processing, fundamentals of spatial filtering, smoothing spatial filters, sharpening spatial filters, Combining spatial enhancement methods

Filtering in the Frequency Domain: Preliminary concepts, The Basics of filtering in the frequency domain, image smoothing using frequency domain filters, Image Sharpening using frequency domain filters, Selective filtering.

UNIT-3

Image Restoration and Reconstruction: A model of the image degradation / Restoration process, Noise models, restoration in the presence of noise only-Spatial Filtering, Periodic Noise Reduction by frequency domain filtering, Linear, Position – Invariant Degradations, Estimating the degradation function, Inverse filtering, Minimum mean
square error (Wiener) filtering, constrained least squares filtering ,geometric mean filter ,image reconstruction from projections.

UNIT-4

Image compression: Fundamentals, Basic compression methods: Huffman coding, Golomb coding, Arithmetic coding, LZW coding, Run-Length coding, Symbol-Based coding, Bit-Plane coding, Block Transform coding, Predictive coding

Wavelets and Multiresolution Processing: Image pyramids, subband coding, Multiresolution expansions, wavelet transforms in one dimensions & two dimensions, Wavelet coding.

UNIT-5

Image segmentation: Fundamentals, point, line, edge detection, thresholding, region –based segmentation.

Morphological Image Processing: Preliminaries, Erosion and dilation, opening and closing, basic morphological algorithms for boundary extraction, thinning, gray-scale morphology, Segmentation using morphological watersheds.

UNIT-6

Color image processing: color fundamentals, color models, pseudo color image processing, basics of full color image processing, color transformations, smoothing and sharpening. Image segmentation based on color, noise in color images, color image compression.

Text Books

1. R. C. Gonzalez and R. E. Woods, Digital Image Processing, 3rd edition, Prentice Hall, 2008.
2. Jayaraman, S. Esakkirajan, and T. Veerakumar," Digital Image Processing", Tata McGraw-Hill Education,2011.

Reference Books

1. Anil K.Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India, 9th Edition, Indian Reprint,2002.
2. B.Chanda, D.Dutta Majumder, "Digital Image Processing and Analysis", PHI, 2009.