Programme- M.Tech.

Power Electronics & Drives

Scheme and Syllabi

w.e.f. Academic Session 2020-2021

BUEST

SCHOOL OF ENGINEERING & EMERGING TECHNOLOGIES

Note for End Term Examination: Attempt five question in all, selection one question each from the

section A,B,C and D Section E is compulsory.

BADDI UNIVERSITY OF EMERGING SCINECES & TECHNOLOGY

DEPARTMENT OF ELECTRICAL ENGINEERING

MASTER OF TECHNOLOGY(EE)

(Four Semesters / full Time)

SCHEME & SYLLABI

SEMESTER-I

SR. No	Course Code	Course Title	L	T	P	Credit
1	PPD-110	Advances in Power Electronics	3			3
2	PPD-111	Advances in Electrical Machines	3			3
3	PPD-112	Microcontroller & MicroProcessor	3			3
4	PPD-XXXX	Elective-I	3			3
5	PPD-XXXX	Elective-II	3			3
6	PPD-105	Electrical Machines & Drives Lab			2	1
7	PPD-113	Seminar	3			3
TOTAL CREDITS						19

SEMESTER-II

SR. No	Course Code	Course Title	L	T	P	Credit
1	PPD-152	Advances Electrical Drives	3			3
2	PPD-154	Modeling & Analysis of Electrical Machines	3			3
3	PPD-155	FACTS	3			3
4	PPD-XXX	Elective-III	3			3
5	PPD-XXX	Elective-IV	3			3
6	PPD-153	Project			6	3
TOTAL CREDITS						18

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

SEMESTER-III						
SR. No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1	PPD-203	Digital Signal Processing	3			3
2	PPD-206	Advances Power System Protection	3			3
3	PPD-XXX	Elective-V	3			3
4	PPD-207	Scientific Computing Lab			2	1
5	PPD-205	Pre-Dissertation				8
TOTAL CREDITS						18

SEMESTER-IV						
SR. No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1	PPD-251	Dissertation				21
2	PPD-XXX	Elective-VI	3			3
TOTAL CREDITS						24

Total Credits:79

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Elective-I

Sr. No	Course Code	Course Title
1	PPD-107	PLC,DCS& SCADA
2	PPD-108	Renewable Energy Sources
3	PPD-109	Digital Control Systems

Elective-II

Sr. No	Course Code	Course Title
1	PPD-114	Special Electrical Machines
2	PPD-115	Intelligent Control
3	PPD-116	Power Quality in Power System

Elective-III

Sr. No	Course Code	Course Title
1	PPD-156	Modern Control Theory
2	PPD-157	Power Semiconductor devices
3	PPD-151	Research Methodology

Elective-IV

Sr. No	Course Code	Course Title
1	PMA-151	Advanced Optimization Techniques
2	PPD-151	Switched Mode Power Conversion
3	PPD-158	Power System Planning

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Elective-V

Sr. No	Course Code	Course Title
1	PPD-208	Power Electronic Control Of AC Drive
2	PPD-209	Static control of DC Drives
3	PPD-158	Analysis of Converter

Elective-VI

Sr. No	Course Code	Course Title
1	PPD-256	Soft Computing
2	PPD-254	Energy Auditing, Conversation & management
3	PPD-257	Solar Power

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

SEMESTER I

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name:- Advances in Power Electronics
Course Code:- PPD-110

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit I

Introduction: Power switching devices overview, Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Device selection strategy –On-state and switching losses, EMI due to switching, Power diodes, Types, forward and reverse characteristics, switching characteristics-rating.

Unit II

Current Controlled Devices: BJT‟s - Construction, static characteristics, switching characteristics; Negative temperature co-efficient and secondary breakdown; Power Darlington Thyristors – Physical and electrical principle underlying operating mode, Two transistor analogy, concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation; comparison of BJT and Thyristor, steady state and dynamic models of BJT & Thyristor.

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Unit III

Phase Controlled Converters: Performance measures of single and three-phase converters with discontinuous load current for R, RL and RLE loads. Effect of source inductance for single and three-phase converters.

AC Voltage Controllers: Single and Three Phase AC Controllers. AC Voltage Controller with PWM Control.

Unit IV

Inverters: Performance parameters, voltage control of three phase inverters-Sinusoidal PWM, Third Harmonic PWM, 60 degree PWM and Space Vector Modulation. Harmonic reductions.

Firing and Protecting Circuits: Necessity of isolation, pulse transformer, Optocoupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT, Over voltage, over current and gate protections; Design of snubbers.

Texts Books:

1. “Power Electronics: Circuits, Devices & Applications” by M.H. Rashid, Prentice Hall of India Ltd, 2004.
2. “Power Electronics” by P.S. Bimbhra , Khanna Publishers, 2006.
3. “A First Course on Electric drives” by S.K. Pillai , New Age International Publishers, 2004.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Reference books:

1. "Power Electronics" by M.D. Singh and K.B. Khanchandani, Tata MC Graw Hill Pub, 2005.
2. "Power Electronics: Converters, Applications and Design" by Ned Mohan, T.M.Undeland and W.P.Robbins, Wiley India Ltd, 2008.
3. "Fundamentals of Electrical Drives" by Gopal K Dubey, Narosa Publications.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name:- Advances in Electrical Machines
Course Code:- PPD-111

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit I

Unified approach to the analysis of electrical machine performance - per unit system - basic two pole model of rotating machines- Primitive machine -special properties assigned to rotor windings - transformer and rotational voltages in the armature voltage and torque equations resistance, inductance and torque matrix. Transformations - passive linear transformation in machines- invariance of power - transformation from three phase to two phase and from rotating axes to stationary axes-Park's transformation.

Unit II

DC Machines: Application of generalized theory to separately excited, shunt, series and compound machines. Steady state and transient analysis, transfer functions. Sudden short circuit of separately excited generator, sudden application of inertia load to separately excited dc motor. Synchronous Machines: synchronous machine reactance and time constants-Primitive machine model of synchronous machine with damper windings on both axes. Balanced steady state analysis-power bangle curves. Transient analysis- sudden three phase short circuit at generator terminals – armature currents and torque. - Transient power angle curve

Unit III

Induction Machines: Primitive machine representation- Steady state operation-Equivalent circuit Double cage rotor representation - Equivalent circuit -Single phase induction motor-Voltage and Torque equations.

Unit IV

Synchronous Machine Dynamics- Classification of stability problems- Angle stability- The swing equation- Normalised swing equation- The power angle equation- Synchronous machine power coefficients- transient power. Angle characteristics- Transient power curve and dynamics- Response to a step change in mechanical power (Pm)- Linear analysis of swing equation- Equal area criterion of Stability (Non-linear analysis of swing equation)-Numerical Integration methods to solve power.

References Books

1. P. S. Bhimbra, „Generalized Theory Of Electrical Machines", Khanna Publishers, 2002
2. Charles V. Johnes, „Unified Theory Of Electrical Machines".

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

3. Adkins, Harley, „General theory of ac machines".

Text Books

1. C. Concordia, „Synchronous Machines".
2. M. G. Say, „Introduction to Unified Theory of Electrical Machines"
3. E. W. Kimbark, „Power System Stability - Vol. II".

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name:- Microcontroller & Microprocessor
Course Code:- PPD-112

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit I
Design of basic microprocessor architectural Concepts : Microprocessor architecture, word Lengths, addressable memory, Microprocessor‟s speed architectural characteristics, registers, instruction, memory addressing architecture, ALU, GPR‟s Control logic & internal data bus.

Unit II
Microprocessor Instructions & Communication: Instruction Set, Mnemonics, Basic Instruction Types, Addressing modes,Microprocessor I/O connecting I/O put to Microprocessor ,Polling and Interrupts , Interrupt and DM. Controllers.
Microprocessor I/O: Data Communication, parallel I/O serial communication, Serial interface and UART modems, I/O devices, D/A,A/D interface, special I/O devices.

Unit III
Microcontroller:Introduction 8051 architecture and programming model. Internal RAM and registers, I/O parts, Interrupt system & Instruction sets.

Unit IV
Advanced Microprocessors: Intel X86 family of advanced Microprocessor, programming model for 86 family. X85 addressing modes, instruction set, hardware. Motorola 68 XXX family of microprocessor, 68XXX addressing modes , instruction set, hardware. Developing Microprocessor Based Products: Introduction to the Design Process, Preparing the specifications, Developing a design, Implementing and Testing and design, Regulatory Compliance Testing, design tool for Microprocessor Development.

Text Books:
1. C.M. Gilmore, “Microprocessors Principals and Application”, MGH
2. Rajkamal, “Embedded System, Architecture & Programming”, TMH

Reference Books:
1. Berry B. Berry, “ Inter Series of microprocessors”, PHI
2. D. V. Hall, “ Microprocessor & Interfacing”, TMH
3. Peatman, “Microprocessor Based System Design”, Pearson

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

SEMESTER II

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name:- Advances in Electrical Drives
Course Code:- PPD-152

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit I

Converter Fed DC Drives: General analysis of Single phase and three phase semi converter and full converter fed drives- separately excited and series motor drives - Evaluation of performance parameters – Dual converter fed drives.

Unit II

Chopper Fed DC Drives: Single quadrant chopper controlled drives - evaluation of performance parameters for separately excited and series motor drives - Two quadrants and four quadrant chopper controlled drives.

Unit III

Induction Motor Drives:

Stator control: Stator voltage control of 3 phase induction motors, effect of voltage variation on motor performance by ac voltage controllers - Variable frequency square wave VSI drives -Twelve step inverters for induction motors - PWM drives - CSI drives. Rotor control: Static rotor resistance control - DC equivalent circuit - Torque equation – slip power recovery-static Kramer drive - AC equivalent circuit - Torque expression.

Unit IV

Vector Control of Induction Motors:

Principle of vector control - rotor flux - oriented control, stator - flux oriented control, Magnetizing flux - oriented control of induction machines. Synchronous Motor Drives: Scalar control - True synchronous and self modes – Vector control - Permanent magnet machine control - Switched reluctance motor and stepper motor drives.

Text Books

1. Sen, P.C.,"Thyristor DC Drives", John Wiley & sons, New York, 1981
2. Pillai, S.K.,"Analysis of Thyristor Power Conditioned Motors", University Press, 1992.
3. Gopal K.Dubey, ”Fundamentals of Electric Drives", Narosa Publications, 1995.
4. Bimal K.Bose, "Power Electronics and variable Frequency Drives - Technology and Application", IEEE Press, 1997.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Reference Books

1. Peter Vas, "Vector control of Ac machines", Oxford University Press, 1990.
2. Bose, B.K.et.al."Microcomputer control of power electronics and drives", IEEE Press, 1987.
3. Leonard, W,"Control of Electric Drives", Springer Verlag, 1985.
4.R.Krishnan ,"Electric motor drives: Modelling , Analysis and Control".PH ,1998

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name:- Modeling and Analysis of Electrical Machines
Course Code:- PPD-154

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit I
Basic Two-pole DC machine - primitive 2-axis machine – Voltage and Current relationship – Torque equation.

Unit II
Mathematical model of separately excited DC motor and DC Series motor in state variable form- Transfer function of the motor - Numerical problems. Mathematical model of D.C. shunt motor D.C. Compound motor in state variable form – Transfer function of the motor - Numerical Problems

Unit III
Liner transformation – Phase transformation (a, b, c to α, β, o) – Active transformation (α .β, o to d, q). Circuit model of a 3 phase Induction motor – Linear transformation - Phase Transformation – Transformation to a Reference frame – Two axis models for induction motor.

Unit IV
Voltage and current Equations in stator reference frame – equation in Rotor reference frame – Equations in a synchronously rotating frame – Torque equation - Equations I state – space form. Circuits model of a 3ph Synchronous motor – Two axis representation of Syn. Motor. Voltage and current Equations in state – space variable form – Torque equation.

Text Books:
1. Thyristor control of Electric Drives - Vedam Subranmanyam.
2. Analysis of Electric Machinery and Drives systems - Paul C. Krause, Oleg wasynezuk, Scott D. Sudhoff.

Reference Books:
1. "Electrical Machinery" by P.S. Bimbhra, Khanna Publishers, Delhi.
2. "Generalized theory of electrical machines" by P.S. Bimbhra, Khanna Publishers, Delhi.
3. "Electric Machinery" by Fitzgerald & Kingsley, MGH.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: FACTS
Course Code: PPD-155

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit I

Introduction

FACTS Concepts: Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters basic types of FACTS controllers, benefits from FACTS controllers. Static shunt compensation: Objectives of shunt compensation, midpoint voltage regulation voltage instability prevention, improvement of transient stability, Power oscillation damping.

Unit II

VAR generating

Variable impedance type static var generators: Thyristor Controlled and Thyristor Switched Reactor(TCR and TSR), Thyristor Switched Capacitor(TSC), Fixed Capacitor Thyristor Controlled Reactor Type Var Generator FC-TCR, Thyristor Switched Capacitor- Thyristor Controlled Reactor Type Var Generator; Switching converter type var generators, Hybrid var generators. Static Var Compensators: SVC and STATCOM-The Regulation Slope, Transfer Function and Dynamic Performance-Transient Stability Enhancement and Power Oscillation Damping; Comparison between STATCOM and SVC: V-I and V-Q Characteristics, Transient Stability, Response Time, Capability to Exchange Real Power, Operation with Unbalanced AC System, Loss Versus Var Output Characteristic.

Unit III

Static Series Compensation

Concept of series capacitive compensation, improvement of transient stability, power oscillation damping; Variable Impedance Type Series Compensators-GTO Thyristor-Controlled Series Capacitor-(GCSC), Thyristor-Switched Series Capacitor(TSSC), Thyristor-Controlled Series Capacitor(TCSC), Basic Operating Control Schemes For GCSC,TSSC and TCSC. Static Synchronous Series Capacitor(SSSC), Transmitted Power Versus Transmission Angle Characteristic, Control Range and VA Rating, Capability to Provide Real Power Compensation, Internal Control; External Control for Series Reactive Compensators.

Unit IV

Power quality (PQ) problem, Voltage sag, Swell , Surges, Harmonic, over voltages, spikes, Voltage fluctuations, Transients, interruption overview of power quality phenomenon , Remedies to improve power quality, power quality monitoring.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Interruptions: Definition, Difference between failure, outage, causes and origin of interruptions, limits for the interruption frequency, limits for the interruption duration, costs of interruption, overview of Reliability , evaluation to power quality, comparison of observations and reliability evaluation.

References books:

1. N.G.Hingorani & L.Gyugyi, *Understanding FACTS*: *Concepts and Technology of Flexible AC Transmission Systems*, IEEE Press, 1999.
2. X.P. Zang, C. Rehtanz and B. Pal, *Flexible AC Transmission Systems: Modeling and Control*, Birkhauser, 2006.

Text Books

1.Y. H. Song and A. T. Johns, *Flexible AC Transmission Systems*, IET, 1999.
2.“ Understanding Power Quality Problems” by Math H J Bollen, IEEE Press.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

SEMESTER III

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: Digital Signal Processing
Course Code: PPD-203

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit I

Introduction: Review of Continuous time and Discrete time signals and systems, linear time invariant (LTI) systems and important properties, Z-transform; Properties of Z-transform, Inverse Z-transform – Analysis of discrete time systems, convolution

Sampling and reconstruction of signals

Digital processing of continuous time signals- sampling, anti-aliasing, sample and hold process, reconstruction of signals, Multirate signal processing ,Quantization noise introduced by analog-to-digital conversion.

Unit II

Discrete fourier transform (DFT)

Review of Fourier series and Fourier transform of continuous time and discrete time signals, Properties of DFT, inverse Discrete time Fourier Transform: properties – circular convolution. Fast Fourier Transform (FFT), various algorithms of FFT, Decimation-in-time (DIT) algorithm-decimation-in-frequency algorithm, Radix-2 DIT and DIF implementation

Unit III

Realization of digital linear systems

Introduction, basic realization block diagram and the signal flow graph, basic structures for IIR and FIR systems (direct form –I, direct form – II, Cascade and Parallel)

DSP Chips & Applications:

TMS C3xSeries: Architectural overview, Types of Addressing, Application.

Unit IV

Design of digital filters

Introduction of digital filters, Magnitude response and phase response of digital filters, Design techniques of FIR Filters: Fourier deries method, Frequency Sampling method, Windowing techniques, Design of IIR Filter: Impulse invariant system, Bilinear transformation, Filter approximations: butterworth, chebyshev, Bessel, elliptic.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Reference Books

1. Digital Signal Processing by David.K.Defatta, Joseph G, Lucas and William S.Hodgkiss John Wiley & sons, 1988.
2. Digital Signal Processing by Sanjit K and Mitra, Tata McGraw Hill, 1998.
3. Digital Signal and Processing by A.V.Oppeheim and R.W.Schaffer, Prentice Hall.

Text Books

1. Digital Signal and Processing by Farooq Hussain, Prentice Hall.
2. Digital Signal Processing-Principles and Applications by Proaikis, Pearson
3. Digital Signal Processing by Vallavraj, TMH

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: Advances Power System Protection
Course Code: PPD-206

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit I

Circuit Breakers: Theory of arc interruption, restriking voltage transients, current chopping in circuit breaker, circuit breaker ratings, duties of switch gear, automatic switch, air circuit breaker, bulk oil, minimum oil, air blast, SF6 CB, vacuum and DC circuit breakers, Design & Testing of CB, Basic concepts recommended for design of CB, Simple testing station, Equipment used in the station, testing procedure, direct test, indirect test.

Unit II

Protective Relays: Nature and causes of faults, consequences, zone of protection, essential qualities, primary and backup protections, relay classification, principal types of electromagnetic relays, i.e. attracted armature, induction disc, induction cup types, Relay Characteristics: Over -current, instantaneous over current, IDMT, directional and differential relays, distance relays, plain impedance, mho, reactance, offset mho type, pilot wire and carrier current protection, neutral grounding.

Unit III

Apparatus Protection: Transformer, generator, motor and bus zone protection, transmission and feeder.

Unit IV

Static and Numerical Relays: Classification of static relays, amplitude and phase comparators, and blockspike and block-average comparators, rectifier type relays. Traveling wave relay, relaying schemes based on microwave and optical fiber link, protection of FACTS devices, digital relaying, its architecture, Numerical Protection: Block diagram of numerical relay, sampling and Digital filtering, Numerical over current protection, Numerical transformer differential protection, Numerical protection of transmission line.

TEXT BOOKS:

1. Power System protection and switchgear by B.Ram, D.N.Vishvakarma: TMH.
2. Fundamental of Power System Protection by Y G Paithankar, S. R. Bhide: PHI
3. Power System Protection & Switch Gear by Ravindra Nathan & Chaner: New Age Pub.
4. Protection and Switchgear by B. Bhalja, R. P. Maheshwari, N. G. Chothani: Oxford University Press.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Reference Books:

1. Protective Relays -Their Theory and Practice Vol.I & II by W.Van: Warrington.
2. Advanced power system analysis and dynamics by L.P.Singh: Wiley Eastern N.Delhi.
3. A course in Electrical Power by Soni, Gupta and Bhatnagar: Dhanpat Rai & Sons.
4. Power System Engg by I.J. Nagrath and D.P. Kothari :TMH.
5. Power System Engineering by V. K. Mehta.
6. Switchgear and protection by S. S. Rao: Khanna Pub

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

ELECTIVE-I

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: PLC DCS AND SCADA
Course Code: PPD-107

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit:I

Introduction to PLC

Automation: fundamentals of industrial automation, need and role of automation, evolution of automation. PLC introduction : types of processes, comparison, evolution of PLC, definition, functions, advantages, Architecture, DI-DO-AI-AO examples and ratings, I/O module, working of PLC, scan time, Installation of PLC, Rack installation, Grounding and shielding, physical, electrical, maintenance requirements, planning, verifying. Troubleshooting, Fault diagnosis techniques. Choosing PLC for application, Types and Specifications of PLC.

PLC programming: Development of Relay Logic Ladder Diagram, Introduction to PLC Programming, Programming devices and languages as per IEC 61131-3 like IL, ST, FBD, CFC, SFC, PLC Timers and Counters, Installation and Troubleshooting. PLC Interfacing: PID Control using PLC, PID instruction. PLC Interface to Hydraulic/Pneumatic circuits, solid-state devices, Need of interfacing. PLC Selection, PLC interface to temperature control loop.

Unit:II

SCADA System

SCADA Concept of SCADA systems, Programming techniques for : Creation of pages, Sequencing of pages, Creating graphics & animation, Dynamos programming with variables, Trending, Historical data storage & Reporting, Alarm management, reporting of events and parameters. Comparison of different SCADA packages. Application Development using SCADA system.

Unit:III

Introduction to DCS

DCS Introduction, Location of DCS in Plant, functions, advantages and limitations, Comparison of DCS with PLC,.DCS components/ block diagram, Architecture, Functional requirements at each level, Database management. Latest trends and developments of DCS, DCS Specification.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Unit:IV

DCS Hardware

Layout of DCS, Controller Details, Redundancy, I/O Card Details, Junction Box and Marshalling Cabinets, Operator Interface, Workstation Layout, different types of control panels, types of Operating Station,. Programming as per IEC 61131-3, Advantages, Overview of Programming Languages, Device Signal Tags, Configuration, Programming for Live Process. Power supply cards details, various display configurations.

Text Books

1. Programmable Logic Controllers, John Webb, Prentice Hall of India.
2. Introduction to Programmable Logic Controllers, Gary Dunning, Delmar Thomson Learning.

References Books

1. Distributed Computer Control for Industrial Automation, Popovik-Bhatkar, Dekkar Publications.
2. Computer Aided Process Control, S. K. Singh, Prentice Hall of India.
3. Computer Based Process Control, Krishna Kant, Prentice Hall of India.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: RENEWABLE ENERGY RESOURCES
Course Code: PPD-108

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit-I

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-II

Wind Energy

Nature of wind – Characteristics – Variation with height and time – Power in wind – Aerodynamics of Wind turbine – Momentum theory – Basics of aerodynamics – Aerofoils 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.

Unit-III

Wind and Biomass Energy Conservation Schemes

Site selection. 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. 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 digestion for biogas – Different digesters – Digester sizing – Applications of Biogas - Operation with I.C.Engine

Unit-IV

Other Renewable Energy Sources

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 –

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

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

References 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

Text Books

1. Solar Energy - Principles of thermal collection and storage/ S.P. Sukhatme / TMH
2. Solar Energy Thermal Processes,/Duffie & Beckman
3. Solar Heating and Cooling / Kreith & Kreider

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: DIGITAL CONTROL SYSTEMS
Course Code: PPD-109

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit:I

Introduction

Advantages of Digital control systems- -Practical aspects of the choice of sampling rate and multirate sampling - Basic discrete time signals - Quantization – Sampling theorem -Data conversion and Quantization- Sampling process- Mathematical modeling- Data reconstruction and filtering of sampled signals – zero-order hold z- transform and inverse z-transform, Relationship between s- plane and z- plane- Difference equation-Solution by recursion and z-transform- pulse transfer functions of the zero-order Hold and relationship between G(s) and G(z)– Bilinear transformation .

Unit:II

Z-Plane Analysis

Digital control systems- Pulse transfer function- z transform analysis of open loop, closed loop systems-Modified z- transfer function- Stability of linear digital control systems-Stability tests.

State space representation of discrete time systems, pulse transfer function matrix, solving discrete time state space equations, state transition matrix and its properties methods for computation of state transition matrix, discretization of continuous time state-space equations

Unit:III

Stability Analysis

Stability analysis of closed loop systems in the Z-plane, Jury stability criterion test-Stability analysis by use of the bilinear transformation and routh stability criterion. Stability analysis using liapumov theorems. Design of digital control systems based on Root locus techniques-Design of digital control based on the frequency response methods-Bilinear transformation and design procedure in the w-plane, lead, lag and Lead-lag compensators and digital PID controllers. Design digital control through dead beat response methods.

Unit:IV

State Feed back controllers and Observers

Concept of controllability and observability-Design of state feedback controller through pole placement-Necessary and sufficient conditions, Ackerman‟s formula, State observers-Full order and Reduced Order observer. Min/Max principle, Linear Quadratic Regulators, Kalman Filters, State Estimation through kalman Filters, Introduction to adaptive controls

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Textbooks:

1. Discrete Time Control Systems-K.Ogata Pearson Education
2. Digital Control systems and State Variables methods by M.Gopal

Reference Books:

1. Automatic Control System by B.C.Kuo (PHI)
2. Control System Components by J.F.Gibsen (MGH)

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

ELECTIVE II

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: SPECIAL ELECTRICAL MACHINES
Course Code: PPD-114

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit I:

Stepper Motors

Constructional features, Principle of operation, Modes of excitation torque reduction in Variable Reluctance (VR) stepping motor.

Characteristics of Stepper Motors

Dynamic characteristics, Drive systems and circuit for open loop control, closed loop control of stepping motor.

Unit II:

Switched Reluctance Motors

Constructional features, Principle of operation. Torque equation, Characteristics, control Techniques, Drive Concept.

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, Controllers-Microprocessors based controller.

Unit III:

Permanent Magnet Synchronous Motors

Principle of operation, EMF, power input and torque expressions, Phasor diagram Power Controllers, Torque speed characteristics, Self control, Vector control, Current control Schemes.

Servomotors

Servomotor – Types – Constructional features – Principle of Operation – characteristics - Control – Microprocessor based applications.

Unit IV:

AC Tachometers

Schematic diagram, Operating principle, numerical problems Linear Motors: Linear Induction Motor (LIM) Classification – Construction – Principle of operation– Concept of Current sheet –Goodness factor – DC Linear Motor (DCLM) types – Circuit equation – DCLM control-applications.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Text Books

1. Miller, T.J.E. “Brushless Permanent Magnet and Reluctance Motor Drives”, Clarendon Press, Oxford, 1989.
2. Kenjo, T, “Stepping Motors and their Microprocessor control”, Clarendon Press, Oxford, 1989.
3. Naser A and Boldea I, “Linear Electric Motors: Theory, Design and Practical Application”, Prentice Hall Inc., New Jersey,1987

References Books

1.Floyd E Saner,”Servo Motor Applications”, Pittman USA, 1993.
2.Kenjo, T and Naganori, S “Permanent Magnet and brushless DC motors”, Clarendon Press, Oxford, 1989.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: INTELLIGENT CONTROL
Course Code: PPD-115

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit I

Introduction to Wavelet Transform

Introduction and motivation. Approaches to intelligent control. Architecture for intelligent control. Symbolic reasoning system, rule-based systems, the AI approach. Knowledge representation. Expert systems. Data Pre-Processing: Scaling, Fourier transformation, principal-component analysis and wavelet transformations

Unit II

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.

Networks: Hopfield network, Self-organizing network and Recurrent network. Neural Network based controller Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox.

Unit III

Genetic Algorithms

Genetic Algorithm: Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other than GA search techniques like tabu search and ant-colony search techniques for solving optimization problems.

Unit-IV:

Fuzzy logic & Neural network applications to Drives

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to Fuzzy logic modeling and control of a system. Fuzzification, inference and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control. Implementation of fuzzy logic controller using Matlab fuzzy-logic toolbox.

Fuzzy logic applications: Design of Fuzzy PI controller for speed control of DC motor- Flux programming efficiency improvement of three phase induction motor-Induction motor speed control-Slip gain tuning of indirect vector control of induction motor-stator resistance estimation.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Neural network applications:-PWM Controller-Selected harmonic elimination PWM-Space vector PWM-Vector controlled drive-feedback signal estimation-speed estimation and flux estimation of induction motor

Text Books

1. Neural Networks: A comprehensive Foundation – Simon Haykins, Pearson Edition, 2003.
2. Fuzzy logic with Fuzzy Applications – T.J.Ross – Mc Graw Hill Inc, 1997.
3. Genetic Algorithms- David E Goldberg.
4. Modern Power Electronics and AC Drives –B.K.Bose-Pearson Publications
5. Artificial Intelligent based Electrical Machines and Drives- Peter Vas, Oxford University Press
6. Neural Network Design-M.T.Hagan, H. B. Demuth and M. Beale, Indian reprint, 2008.

References Books

1. Principles of Neurocomputing for science and Engineering,- Fredric M.Ham and Ivica Kostanic, McGraw Hill, 2001.
2. Neural Network Fundamentals with Graphs, Algorithms and Applications, N.K. Bose and P.Liang, Mc-Graw Hill, Inc. 1996.
3. Intelligent System- Modeling, Optimization and Control- Yung C. Shin and Chengying Xu,CRC Press, 2009.
4. Soft computing & Intelligent Systems- Theory & Applications – N.K.Sinha and Modan M Gupta. Indian Edition, Elsevier, 2007.
5. Fuzzy logic Intelligence, Control, and Information- John Yen and Reza Langari, Pearson Education, Indian Edition, 2003.
6. Fuzzy Control and Fuzzy Systms, Witold Pedrycz, Overseas Press, Indian Edition, 2008.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: POWER QUALITY IN POWER SYSTEM
Course Code: PPD-116

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit:I

Introduction To Power Quality

Introduction, The power quality evaluation procedure-Need for a consistent-Vocabulary, General classes of power quality problems, Transients, Long-Duration voltage variations, Short-Duration voltage variations, Voltage Imbalance, waveform distortion, voltage fluctuation, Power frequency variations, Power quality terms, Ambiguous Terms, CBEMA and ITI curves. Introduction-Common power frequency disturbances-Cures for low frequency disturbances-Voltage tolerance criteria

Unit:II

Voltage Sags and Interruptions

Sources of sags and interruptions - Estimating Voltage sag performance - Fundamental principles of protection - Solutions at the End - User level - Evaluating the economics of different ride through alternatives – Motor starting sags - Utility system fault clearing issues. Sources of transient over voltages - Principles of over voltage protection - Devices for over voltage protection - Utility capacitor switching Transients - Utility system Lightning protection - Managing Ferroresonance - Switching Transients problems with loads - Computer tools for transient analysis.

Unit:III

Fundamentals of Harmonics

Harmonic Distortion-Voltage versus current distortion-Harmonic versus Transients-Power system Quantities under non sinusoidal conditions-Harmonic indices-Harmonic sources from commercial loads-Harmonic sources from industrial loads-Locating harmonic sources-System response characteristics-Effects of harmonic distortion- Inter harmonics. Harmonic distortion evaluations-Principles for controlling harmonics-Where to control harmonics-Harmonic study-Devices for controlling harmonic distortion-Harmonic filter design-Case studies-Standards on harmonics

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Unit:IV

Long Duration Voltage Variations

Principles of regulating the voltage-Devices for voltage regulation-Utility voltage regulator application-Capacitors for voltage regulations-End user capacitor application-Regulating utility voltage with distributed resources-Flickers

Power Quality Monitoring

Monitoring considerations-Historical perspective of power quality measuring instruments-Power quality measurement equipment-Assessment of power quality measurement data-Application of intelligent systems-Power quality monitoring standards

Reference books

1. Electrical power systems quality-Roger C.Dugan-Graw- Hills
2. Power quality- C.Sankaran, CRC Press.

Texts Books:

1. Power System Engg: by I.J.Nagrath and D.PKothari (TMH)
2. A Course in Electrical Power by Gupta, Soni & Bhatnagar (Dhanpat Rai & Sons).

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

ELECTIVE III

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: MODERN CONTROL THEORY
Course Code: PPD-156

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit :I

Introduction

Fields, Vectors and Vector Spaces – Linear combinations and Bases – Linear Transformations and Matrices – Scalar Product and Norms – Eigen values, Eigen Vectors and a Canonical form representation of Linear operators – The concept of state – State Equations for Dynamic systems – Time invariance and Linearity – Nonuniqueness of state model – State diagrams for Continuous – Time state model.

Linear Continuous time model for physical systems – Existence and Uniqueness of Solutions to Continuous – Time State Equations – Solutions – Linear Time Invariant Continuous – Time State Equations – State transition matrix and it‟s properties

Unit:II

Controllability and Observability

General concept of Controllability - General concept of Observability Controllability tests for Continuous – Time Invariant systems - Observability tests for Continuous - Time Invariant systems - Controllability and Observability of state model in Jordan Canonical form - Controllability and Observability Canonical forms of State model.

Introduction – Non Linear Systems – Types of Non – Linearities – Saturation – Dead – Zone – Backlash – Jump Phenomenon etc; - Singular Points – Introduction to Linearization of nonlinear systems, properties of Non Linear Systems – Describing function – describing function analysis of nonlinear systems- Stability analysis of Non – Linear systems through describing functions

Unit:III

Non Linear Systems

Introduction to phase – plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase – plane analysis of nonlinear control systems. Stability in the sense of Lyapunov, Lyapunov‟s stability and Lyapunov‟s instability theorems – Stability Analysis of the Linear Continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski‟s method.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Uni:IV

State Feedback Controllers and Observers

State Feedback Controller design through Pole Assignment – state observers: Full order and Reduced order. Introduction to optimal control – Formulation of optimal control problems – calculus of variations – fundamental concepts, functional, variation of functional – fundamental theorem of theorem of Calculus of variations – boundary conditions – constrained minimization – formulation using Hamiltonian method
– Linear quadratic regulator

Reference books:

1. Modern Control System Theory by M. Gopal – New Age International – 1984
2. Modern Control Engineering by Ogata. K – Prentice Hall – 1997

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: POWER SEMICONDUCTOR DEVICES
Course Code: PPD-157

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit:I

Overview of Power Switching Devices: Introduction to power switching devices, classification of devices, controlled and un-controlled devices, i-v characteristics of ideal and real switching devices, Power diode: Device structure and i-v characteristics, ratings & specifications, switching characteristics, reverse recovery, classification of various diodes: Schotky diode, line frequency diodes, fast recovery diodes,

Unit:II

Power Transistors & MOSFRTS: Device structure and i-v characteristics, ratings & specifications, switching characteristics, ON to OFF and OFF to ON state transitions, ON/OFF transition loss analysis, driver circuit.

Power MOSFETs**:** Device structure and i-v characteristics, ratings & specifications, switching characteristics, ON to OFF and OFF to ON state transitions, ON/OFF transition loss analysis, driver circuit.

Unit:III

IGBT: Device structure and i-v characteristics, ratings & specifications, switching characteristics, ON to OFF and OFF to ON state transitions, ON/OFF transition loss analysis,. Comparison of all the above devices with reference to power handling capability, frequency of operation, driver circuit, .emerging power switching devices.

Unit:IV

Operation and Protection of Switching Devices: Device protection against over voltage/currents, di/dt and dv/dt; safe operating area, design of snubbers for power devices.

Thermal Management**:** Conduction and transition losses computation, thermal model of the device, steady-state temperature rise, electrical equivalent circuit of thermal model, sizing of the heat sink.

Passive Components**:** Magnetic circuit, review of design of line frequency inductors and transformers, design of high frequency inductors and transformers.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Text book

1. Power Electronics Circuits- B. W. Williams
2. Power Electronics Circuits, Devices and Applications – M. H. Rashid-PHI-

Reference Books

1. Power Electronics –Converters, Applications and Design – Mohan and Undeland-John Wiley & Sons
2. Power Electronics: L. Umanand

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

ELECTIVE IV

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: SWITCHED MODE POWER CONVERSION
Course Code: PPD-151

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit:I

Single-switch isolated converters

Requirement for isolation in the switch-mode converters, transformer connection, Forward and flyback converters, power circuit and steady-state analysis. Power circuit and steady-state analysis, utilization of magnetic circuits in single switch and push-pull topologies. Half bridge and full-bridge converters**,** Power circuit and steady-state analysis, utilization of magnetic circuits and comparison with previous topologies.

Unit:II

Dynamic Analysis of DC-DC converters:

Formulation of dynamic equation of buck and boost converters, averaged circuit models, linearization technique, small-signal model and converter transfer functions.

Review of frequency-domain analysis of linear time-invariant systems, concept of bode plot, phase and gain margins, bandwidth, controller specifications, proportional(P), proportional plus integral (PI), proportional plus integral plus integral controller (PID), selection of controller parameters.

Unit:III

Resonant Converters

Classification of Resonant converters-Basic resonant circuits- Series resonant circuit-parallel resonant circuits- Resonant switches. Quasi-Resonant Converters-I: Concept of Zero voltage switching, principle of operation, analysis of M-type and L-type Buck or boost Converters.

Unit: IV

Converters

Quasi-Resonant Converters-II: Concept of Zero current switching, principle of operation, analysis of M-type and L-type Buck or boost Converters.

Text Books:

1. Fundamentals of Power Electronics – Robert Erickson and Dragon Maksivimovic, Springer Publications.
2. Power Electronics–Issa Batarseh- John Wiely.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Reference Books

1. Elements of Power Electronics - Philip T.Krein – Oxford University Press
2. Power Electronics, L. Umanand, Tata Mc-Graw Hill

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: POWER SYSTEM PLANNING
Course Code: PPD-158

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit-I

Introduction: Power System planning, objective, stages in planning & design, Transition from planning to operation.

Unit-II

Generating System capability Planning: Probabilistic models of generating units, growth rate, Rate of generation capacity, Outage performance and system evaluation of loss of load and loss of energy indices, Power supply availability assessment.

Unit-III

Interconnected Systems: Multi area reliability analysis, Power pool operation and power exchange energy contracts, quantification of economic and reliability benefits of pool operation.

Unit-IV

Demand/ Energy forecasting: Electricity consumption pattern, Peak demand and energy forecasting by trend and economic projection methods.

Power System expansion planning: Formulation of least cost optimization problem involving capital, operation and maintenance costs of candidate units of different types.

Reference books

1. Electrical Power Systems Planning, by A.S. Pabla, Macmillan Publishers India.
Electrical Power Planning for Regulated and Deregulated Markets, by Wiley-IEEE Press

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

ELECTIVE V

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: POWER ELECTRONIC CONTROL OF AC DRIVES
Course Code: PPD-208

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit:I

Introduction

Review of steady-state operation of Induction motor, Scalar control- Voltage fed Inverter control-Open loop volts/Hz control-Speed control with slip regulation-Speed control with torque and Flux control-Current controlled voltage fed Inverter Drive. Current-Fed Inverter control-Independent current and frequency control-Speed and flux control in Current-Fed Inverter drive-Volts/Hz control of Current-Fed Inverter drive-Efficiency optimization control by flux program.

Unit:II

Slip power recovery schemes

Slip-power recovery Drives-Static Kramer drive-Phasor diagram-Torque expression-Speed control of a Kramer drive-Static scherbius drive-Modes of operation. Principles of vector control, Direct vector control, derivation of indirect vector control, implementation – block diagram; estimation of flux, flux weakening operation. Synchronous motor and its characteristics- Control strategies-Constant torque angle control- power factor control, constant flux control, flux weakening operation, Load commutated inverter fed synchronous motor drive, motoring and regeneration, phasor diagrams.

Unit:III

PMSM and BLDC Drives

Characteristics of permanent magnet, synchronous machines with permanent magnet, vector control of PMSM- Motor model and control scheme. Modeling of PM brushless dc motor, drive scheme -Three-phase full wave Brushless dc motor -Sinusoidal type of Brushless dc motor - current controlled Brushless dc motor Servo drive.

Unit:IV

Variable Reluctance Motor Drive

Variable Reluctance motor drives- Torque production in the variable reluctance motor -Drive characteristics and control principles - Current control variable reluctance motor servo drive.

Text Book:

1. Electric Motor Drives Modeling, Analysis & control -R. Krishnan- Pearson Education
2. Modern Power Electronics and AC Drives –B. K. Bose-Pearson Publications.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

3. Power Electronics control of AC motors – MD Murphy & FG Turn Bull Pergman Press - 1st edition-1998

Reference Books

1. Fundamentals of Electrical Drives – G.K. Dubey – Narosa Publications -1995
2. Power Semiconductor drives- G.K. Dubey-Prentice hall

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: STATIC CONTROL OF DC DRIVES
Course Code: PPD-209

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit:I

Analysis of DC motors

Separately excited DC motors, Shunt motor, series motor and compound motor. Separately excited DC motors with rectified single phase supply- single phase semi converter and single phase full converter for continuous and discontinuous modes of operation – power and power factor. Three phase semi converter and three phase full converter for continuous and discontinuous modes of operation – power and power factor – Addition of Free wheeling diode – Three phase double converter.

Unit:II

Three phase naturally commutated bridge rectifier - inverter

Three phase controlled bridge rectifier with passive load impedance, resistive load and ideal supply – Highly inductive load and ideal supply for load side and supply side quantities, shunt capacitor compensation, three phase controlled bridge rectifier inverter. Open loop Transfer functions of DC Motor drive- Closed loop Transfer function of DC Motor drive – Phase-Locked loop control.

Unit:III

Chopper controlled DC motor drives

Principle of operation of the chopper – Four quadrant chopper circuit – Chopper for inversion – Chopper with other power devices – model of the chopper –input to the chopper – Steady state analysis of chopper controlled DC motor drives – rating of the devices. Speed controlled drive system – current control loop – pulse width modulated current controller – hysteresis current controller – modeling of current controller – design of current controller

Unit:IV

Simulation of DC motor Drives

Dynamic simulations of the speed controlled DC motor drives – Speed feedback speed controller – command current generator – current controller.

References Books

1. Power Electronics and Motor Control – Shepherd, Hulley, Liang – II Edition, Cambridge University Press
2. Power Electronic Circuits, Devices and Applications – M. H. Rashid – PHI.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Text Books

1. Electric Motor Drives Modeling, Analysis and Control – R. Krishnan, Prentice Hall India.
2. Fundamentals of Electric Drives – G. K. Dubey – Narosa Publications – 1995.
3. Power Semiconductor drives – G. K. Dubey

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: ANALYSIS OF CONVERTERS
Course Code: PPD-158

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit:I

Single Phase AC voltage Controllers

Single Phase AC Voltage Controllers with RL and RLE loads-ac voltage controllers with PWM control-Effects of source and load inductances –synchronous tap changers – Application- numerical 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.

Unit :II

Single phase 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 Discontinuous load current-three phase dual converters-Power factor improvements-three phase PWM-twelve pulse converters- numerical problems.

Unit:III

Power Factor Correction Converters

Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, and steady state- analysis, three phase boost PFC converter

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.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Unit:IV

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

Textbooks

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.

Reference books

1. "Power Electronics" by M.D. Singh and K.B. Khanchandani, Tata MC Graw Hill Pub, 2005.
2. "Power Electronics: Converters, Applications and Design" by Ned Mohan, T.M. Undeland .

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

ELECTIVE VI

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: SOFT COMPUTING
Course Code: PPD-256

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

UNIT:I

Basic tools of soft computing – Fuzzy logic, neural network , evolutionary computing.

Fuzzy Logic System:Basic of fuzzy logic theory , crisp and fuzzy sets, Basic set operation like union , interaction , complement , T-norm , T-conorm , composition of fuzzy relations, fuzzy if-then rules , fuzzy reasoning. Fuzzy inference System: Zadeh‟s compositional rule of inference, defuzzification , Mamdani Fuzzy Model, Sugeno Fuzzy Model, Introduction to type –II Fuzzy System.

Unit:II

Neural Network:

Supervised NN:Single layer network, Perception , Activation function, Adaline , Gradient descent method, least square training algorithm, Multilayer perceptron , error back propagation, generalized delta rule, Radial Basis Function Network, interpolation and approximation RBFNS, comparison between RBFN and MLP, Support Vector Machines : Optimal hypeplane for linearly separable patterns, optimal hyperplane for non-linearly separable patterns. Inverse Modeling. Unsupervised NN and other NN:Competitive learning networks, kohonen self organizing networks, learning vector quantization, Hebbian Learning Hopfield Network: Content addressable nature, binary and continuous valued Hopfield network , simulated annealing NN. Recurrent Neural Network: NARX Model , Simple Neural Network , State – Space Model , Back Propagation Through Time (BPTT) Algorithm , Real-time Recurrent Learning (RTRL) Algorithm.

Unit:III

Neuro-Fuzzy Modeling: Adaptive Neuro-Fuzzy Inference System (ANFIS), ANFIS architecture, Hybrid Learning Algorithm , modeling of a three input nonlinear function , simulation of on-line identification in control system.

Data Clustering Algorithms-k-means clustering, fuzzy c-means clustering, subtractive clustering.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Unit:IV

Evolutionary and Bio Inspired Computing

Evolutionary computing: Genetic algorithm: Basic concept , encoding , fitness function , Reproduction , Basic genetic programming concepts , differences between GA and Traditional optimization methods , Applications, Variants of GA.

Bio Inspired optimization Techniques: Particle Swarm optimization, Ant colony optimization, Bacteria foraging method , Applications.

Text Book

1. Neuro-Fuzzy and soft computing by J S R Jang, CT Sun and E.Mizutani , PHI Pvt. Ltd.
2. Principles of soft computing –by sivandudam and Deepa publisher –John mikey India.
3. S.haykins- Neural Networks: A comprehensive foundation.

Reference books

1. Genetic Algorithms – by D. Goldberg.
2. Neural Networks, Fuzzy Logic and Genetic Algorithms – Synthesis & Applications- By Rajasekran

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: ENERGY AUDITING, CONSERVATION & MANAGEMENT

Course Code: PPD-254

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit:I

Basic Principles Of Energy Audit

Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit.

Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting. Energy manger, Qualities and functions, language, Questionnaire - check list for top management.

Unit:II

Energy Efficient Motors

Energy efficient motors , factors affecting efficiency, loss distribution , constructional details , characteristics - variable speed , variable duty cycle systems, RMS hp- voltage variation- voltage unbalance- over motoring- motor energy audit.

Unit:III

Power Factor Improvement, Lighting

Power factor – methods of improvement, location of capacitors , Pf with non linear loads, effect of harmonics on p.f. , p.f motor controllers - Good lighting system design and practice, lighting control ,lighting energy audit. Energy Instruments- watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers, application of PLC.

Unit:IV

Economic Aspects and Analysis

Economics Analysis-Depreciation Methods, time value of money, rate of return , present worth method , replacement analysis, life cycle costing analysis - Energy efficient motors. Calculation of simple payback method, net present worth method- Power factor correction, lighting - Applications of life cycle costing analysis, return on investment .

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Text Books:

1. Energy management by W.R. Murphy & G. Mckay Butter worth, Heinemann publications.
2. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd-2nd edition, 1995
3. Energy management by Paul o‟ Callaghan, Mc-graw Hill Book company-1st edition, 1998

Reference Books

1. Energy management hand book by W.C.Turner, John wiley and sons
2. Energy management and good lighting practice : fuel efficiency- booklet12-EEO Promised.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Course Name: Solar Power
Course Code: PPD-257

Assessment and Evaluation Components	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	25
Mid Term Tests (MTE)	20
Attendance Marks	05
End Term Examination	50
Total	**100**

L	T	P	Cr
3	0	0	3

Unit I

Introduction :Climate Change & Energy Access, Benefits of Solar Electricity, Standalone photovoltaic applications Occupational Health & Safety Potential Hazards, Safety Equipment, Site Safety.

Photovoltaic Technology overview Basic of Solar photovoltaic, Different types of Solar cells, Characteristics of Solar cell, STC & NOCT, Factors Affect the Output of Solar Module, Combining cells & Curves, Electrical Protection of PV Modules, Determining Module Energy Output, Module reliability

Unit II

Solar Radiation Irradiation & Peak Sun hours, Sun path Diagram & Position Tilting of Solar Array, Solar Radiation Data. Battery Technology Purpose, Types & Classification of Batteries in PV System, Lead Acid, Nickel- Cadmium, NiMH, Li-on, Vanadium Redox batteries, Battery Capacity , Charging, Parameter, Gassing, Over Charge, Efficiency, Selection Criteria & Auxiliary equipment , Combining Battery

Unit III

Charge Controller Purpose, Terminology Functions & Configuration of Charge Regulator, Voltage regulation set point selection, Selecting charge regulator Inverter Technology Standalone vs Grid connected inverter power rating, Efficiency , Output Wave foam, Characteristics & Surge Power System Design General Skill, Design Process, Criteria, Configuration , Nominal Voltage & Load & Energy Demand Assessment System Sizing Basic Principles of System sizing over, Supply Co-efficient, Battery Sizing, Array Sizing, Charge regulator Sizing, Inverter Sizing System Wiring & Protection Selection of Cable & Sizing, Array & Battery Bank Wiring , Electrical Protection Lightning Protection & System Earthling

Unit 4

Installation Commissioning & Maintenance Site Assessment , Planning, Visit & Analysis, Array Mounting & Foundation, Battery Location & Compartment Design, System Component Pre wiring & Testing, Tools for Installation & Processing, System Commissioning & Maintenance & Trouble Shooting.

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.

Text Books:

1. Solar Power Handbook edition 2014 by Mr Michael Boxwell Publisher: Greenstream Publishing Edition no. 8 (12/06/2013)
2. Solar Energy Engineering Processes and Systems by Soteris A. Kalogirou

Reference Books :

1. Solar Energy by Andy Walker

Note for End Term Examination: Attempt five question in all, selection one question each from the section A,B,C and D Section E is compulsory.