COURSE SCHEME
EXAMINATION SCHEME
ABSORPTION SCHEME
&
SYLLABUS

Of

First, Second, Third & Fourth Semester
Choice Base Credit System (CBCS)

Of
Master of Technology (M.Tech)

in
Power Electronics and Power System
(PEPS)

Of
RASHTRASANT TUKDOJI MAHARAJ
NAGPUR UNIVERSITY, NAGPUR

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Scheme of Teaching and Examination
I Semester M. Tech. CBCS Power Electronics and Power System (PEPS)

Subject Code	Subject	Teaching Scheme			Examination Scheme				
					Theory/ Practical				
		Hours per week		No. of Credits	Duration of Paper (Hrs.)	Max. Marks	Max. Marks	Total Marks	Min. Passing Marks
		L	P			University Assessment	College Assessment		
PGPEPS 101T	Advanced Power Electronics	4	-	4	3	70	30	100	50
PGPEPS 102T	Power System Modeling	4	-	4	3	70	30	100	50
PGPEPS 103T	Advanced Control Theory	4	-	4	3	70	30	100	50
PGPEPS 104T	Elective –I	4	-	4	3	70	30	100	50
PGOPEN 105T	Elective –II (Open)	4	-	4	3	70	30	100	50
PGPEPS 106P	Advanced Power Electronics	-	2	1	-	50	50	100	50
PGPEPS 107P	Power System Simulation	-	2	1	-	50	50	100	50
Total		20	4		-	450	250	700	-
Semester Total		24		22	700 Marks				
Elective –I (Core)					1.Power System Dynamics and Control 2. Application of Microcontroller in Electrical System 3. Micro and Smart Grid				
Elective-II (Open)					List of Open Electives from various discipline is attached				

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Scheme of Teaching and Examination
II Semester M. Tech. CBCS Power Electronics and Power System (PEPS)

Subject Code	Subject	Teaching Scheme			Examination Scheme				
					Theory/ Practical				
		Hours per week		No. of Credits	Duration of Paper (Hrs.)	Max. Marks	Max. Marks	Total Marks	Min. Passing Marks
		L	P			University Assessment	College Assessment		
PGPEPS 201T	HVDC and FACTS	4	-	4	3	70	30	100	50
PGPEPS 202T	Power Quality	4	-	4	3	70	30	100	50
PGPEPS 203T	Advanced Electrical Drives	4	-	4	3	70	30	100	50
PGPEPS 204T	Elective –III	4	-	4	3	70	30	100	50
PGFD 205T	Research Methodology	4	-	4	3	70	30	100	50
PGPEPS 206P	Power Quality Lab	-	2	1	-	50	50	100	50
PGPEPS 207P	Advanced Electrical Drives	-	2	1	-	50	50	100	50
Total		20	4		-	450	250	700	-
Semester Total		24		22	700 Marks				
Elective –III (Core)					1. Energy Audit and Management 2. Converter for Non Conventional Energy Sources 3. Power System Planning				

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Scheme of Teaching and Examination
III Semester M. Tech. CBCS Power Electronics and Power System (PEPS)

Subject Code	Subject	Teaching Scheme			Examination Scheme				
					Theory/ Practical				
		Hours per week		No. of Credits	Duration of Paper (Hrs.)	Max. Marks University Assessment	Max. Marks College Assessment	Total Marks	Min. Passing Marks
		L	P						
PGOPEN 301T	Elective –IV (Open)	4	-	4	3	70	30	100	50
PGFD 302T	Project Planning and Management	4	-	4	3	70	30	100	50
PGPEPS 303P	Project Seminar	-	8	8	-	--	200	200	100
Total		8	8	16	-	140	260	400	-
Semester Total		16		16	400 Marks				
Elective-IV (Open)					List of Open Electives from various discipline is attached				

Note: For the teaching work load calculation for Project Seminar, work load will be 3 hours per week per project

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Scheme of Teaching and Examination
IV Semester M. Tech. CBCS Power Electronics and Power System (PEPS)

Subject Code	Subject	Teaching Scheme			Examination Scheme				
					Theory/ Practical				
		Hours per week		No. of Credits	Duration of Paper (Hrs.)	Max. Marks University Assessment	Max. Marks College Assessment	Total Marks	Min. Passing Marks
		L	P						
PGPEPS 401P	Project	-	16	16	-	400	--	400	200
Semester Total		16		16	400 Marks				

Note: For the teaching work load calculation for project, work load will be 6 hours per week per project

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Engineering & Technology
Absorption Scheme for the students of M.Tech. Power Electronics and Power System (PEPS) from Old Semester pattern to New CBCS Semester Pattern
I Semester M. Tech. Power Electronics and Power System (PEPS)

Subject Code	Name of the Subject in New CBCS Pattern	Subject Code	Name of the Subject in old Pattern
PGPEPS 101T	Advanced Power Electronics	IFPEPS01	Advanced Power Electronics (Theory)
PGPEPS 102T	Power System Modeling	IFPEPS04	Power System Modeling
PGPEPS 103T	Advanced Control Theory	IIFPEPS02	Advanced Control theory (Theory)
PGPEPS 104T	Elective –I (Core) Power System Dynamics and Control	IIIFPEPS01	Power System Dynamics and Control (Theory)
PGOPEN 105T	Elective –II (Open) Artificial Intelligence	IIIFPEPS03	Elective –II (Artificial Intelligence system)
	Elective –II (Open)*		Elective –II (Any other Elective except Artificial Intelligence system)
PGPEPS 106P	Advanced Power Electronics	IFPEPS01	Advanced Power Electronics (Practical)
PGPEPS 107P	Power System Simulation	IFPEPS05	Processor Application to Electrical Power System (Practical)
--	--	IFPEPS02	Electrical Power Distribution System (Theory)
--	--	IFPEPS03	HVDC Power Transmission (Theory)
--	--	IFPEPS05	Processor Application to Electrical Power System (Theory)

The Students who fail to clear any subject(s) of the I Semester Old Pattern by the last chance prescribed, shall be required to clear the respective equivalent subject of I Semester (New Pattern) along with the additional subject marked with (*). The Theory and Practical College and university Assessment Marks of old Pattern will be converted into the same proportion in New Pattern. The College Assessment Marks of the Additional Theory/ Practical Subject marked with (*) will be taken in same proportion of the average College Assessment Marks in all the theory / Practical subject of old pattern in the same semester.

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Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Engineering & Technology
Absorption Scheme for the students of M.Tech. Power Electronics and Power System (PEPS) from Old Semester pattern to New CBCS Semester Pattern
II Semester M. Tech. Power Electronics and Power System (PEPS)

Subject Code	Name of the Subject in New CBCS Pattern	Subject Code	Name of the Subject in old Pattern
PGPEPS 201T	HVDC and FACTS	IFPEPS03	HVDC Power Transmission (Theory)
PGPEPS 202T	Power Quality	IIFPEPS03	Elective –I Power Quality (Theory)
	Power Quality**		Elective –I (any other Subject except Power Quality (Theory)
PGPEPS 203T	Advanced Electrical Drives	IIFPEPS01	Advanced Power Electronics Drives (Theory)
PGPEPS 204T	Elective –III (Core) (Energy Audit and Management)	IIFPEPS04	Energy Management System
PGFD 205T	Research Methodology*	--	--
PGPEPS 206P	Power Quality Lab	IIFPEPS06	Power System Simulation lab (Practical)
PGPEPS 207P	Advanced Electrical Drives	IIFPEPS01	Advanced Power Electronics Drives (Practical)
--	--	IIFPEPS02	Advanced Control theory (Theory)
--	--	IIFPEPS05	Power Electronics Application in Power System (Theory)

The Students who fail to clear any subject(s) of the II Semester Old Pattern by the last chance prescribed, shall be required to clear the respective equivalent subject of II Semester (New Pattern) along with the additional subject marked with (*). The Theory and Practical College and university Assessment Marks of old Pattern will be converted into the same proportion in New Pattern. The College Assessment Marks of the Additional Theory/ Practical Subject marked with (*) will be taken in same proportion of the average College Assessment Marks in all the theory / Practical subject of old pattern in the same semester.

.** Elective –I (any other Subject except Power Quality (Theory)) Students has to clear the Additional Subject Power Quality.

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Engineering & Technology
Absorption Scheme for the students of M.Tech. Power Electronics and Power System (PEPS) from Old Semester pattern to New CBCS Semester Pattern
III Semester M. Tech. Power Electronics and Power System (PEPS)

Subject Code	Name of the Subject in New CBCS Pattern	Subject Code	Name of the Subject in old Pattern
PGOPEN 301T	Elective –IV (Open) PLC AND SCADA	IFPEPS02	Electrical Power Distribution System (Theory)
PGFD 302T	Project Planning and Management*	--	--
PGPEPS 303P	Project Seminar	IIIFPEPS04	Project Phase-I (Seminar)
--	--	IIIFPEPS01	Power System Dynamics and Control (Theory)
--	--	IIIFPEPS02	Circuit Simulation in PE and PS Design lab
--	--	IIIFPEPS03	Elective –II

The Students who fail to clear any subject(s) of the III Semester Old Pattern by the last chance prescribed, shall be required to clear the respective equivalent subject of III Semester (New Pattern) along with the additional subject marked with (*). The Theory and Practical College and university Assessment Marks of old Pattern will be converted into the same proportion in New Pattern. The College Assessment Marks of the Additional Theory/ Practical Subject marked with (*) will be taken in same proportion of the average College Assessment Marks in all the theory / Practical subject of old pattern in the same semester.

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Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Faculty of Engineering & Technology
Absorption Scheme for the students of M.Tech. Power Electronics and Power System (PEPS) from Old Semester pattern to New CBCS Semester Pattern
IV Semester M. Tech. Power Electronics and Power System (PEPS)

Subject Code	Name of the Subject in New CBCS Pattern	Subject Code	Name of the Subject in old Pattern
PGPEPS 401P	Project	IVFPEPS01	Project Phase –II (Dissertation & viva vice)

The Students who fail to clear any subject(s) of the IV Semester Old Pattern by the last chance prescribed, shall be required to clear the respective equivalent subject of IV Semester (New Pattern) along with the additional subject marked with (*). The Theory and Practical College and university Assessment Marks of old Pattern will be converted into the same proportion in New Pattern. The College Assessment Marks of the Additional Theory/ Practical Subject marked with (*) will be taken in same proportion of the average College Assessment Marks in all the theory / Practical subject of old pattern in the same semester.

PGIDC101T/PG IPS101T/PGPEPS 101T

Advanced Power Electronics

(Common to M.Tech CBCS IDC, M.Tech CBCS PEPS and M.Tech CBCS IPS)

Course Objective:

To understand the characteristics, capabilities, ratings, limitations and protection of various power semiconductor switches used for various Power Electronic applications.

To understand the performance and analysis of low frequency switched and high frequency switched AC to AC, DC to DC and DC to AC power electronic converters for various applications.

To understand various control schemes and soft switching techniques in industrial applications.

Describe the structure of Electric Drive systems and their role in various applications such as flexible production systems, energy conservation, renewable energy, transportation etc., making Electric Drives an enabling technology.

Study and understand the different types of drives and selection of drive and power converter for particular application.

Study and understand the operation of electric motor drives controlled from a power electronic converter and to introduce the design concepts of controllers for closed loop operation.

Study and understand special motor drives and their control.

Course Outcome:

After the completion of this course, the students shall be able to:

Develop in depth knowledge of advanced power electronics devices.

Study, design and analyze the ac to ac converters.

Study, design and analyze dc to dc converters with their applications.

Understand and analyze various resonant and soft switching techniques for converters.

Study, design and analyze the dc to ac converters.

Understand the operation of modern power converters and multilevel inverters.

Understand the basic principles of power electronics in drives and its control, types of drives and basic requirements placed by mechanical systems on electric drives.

Understand the operation of 1ϕ & 3ϕ converter drives for separately excited & series DC motors.

Learn speed control of induction motor drives in an energy efficient manner using power electronics.

Unit-I: Power Semiconductor Devices

Characteristics, protection and industrial applications of power devices. Various pulse width modulation techniques for different converter topologies.

Unit-II: AC-AC Converters

Introduction, single and three-phase ac–ac voltage controllers, Cyclo-converter, Matrix converters, application of ac-ac converters.

Unit-III: DC-DC Converters

Introduction, step-down converters- Buck, transformer version of buck converters, step up converters, Buck-Boost converters, application of dc to dc converters

Unit IV-: Resonant and soft switching converters

Introduction, classification, resonant switch-ZC Resonant switch, ZV Resonant switch, Quasi resonant converters, multi resonant converters, load resonant converters and their applications.

Unit V-: DC-AC converters

Introduction, classification, single-phase VSI (Half & Full Bridge), Three -phase VSI with SPWM, SVPWM, Selective harmonic elimination, SPWM with zero sequence signal injection with industrial applications.

Text Books:

1. "Power electronics handbook by Muhammad Rashid , Academic Press.

2. "Modern Power Electronics" by P. C. Sen , A. H. Wheeler Publishing Co.

3. "Thyristorized Power Controller " by Dubey , Joshi Doradla Sinha PHI Publication

Reference Books:

1. "Power Electronics" Cyril W Lander ,MHL

2. "Power Electronics", Ned Mohan, Tora M. Udeland, William P. Riobbins, John Wiley & sons

3. Related IEEE Papers / NPTEL Lectures.

PGIPS102T/PGPEPS102T

Power System Modeling

(Common to M.Tech CBCS PEPS and M.Tech CBCS IPS)

Course objective:

To analyze the modeling of long transmission line and compare the same with medium and short transmission line

To analyze the modeling of single phase transformer and three phase transformer per phase per unit basis.

To develop a simple but physically meaningful model of the synchronous machine.

To study load modeling w.r.t voltage & frequency point of view and acquire the knowledge of AC & DC excitation system

Course Outcome:

After the completion of this course, student will be able to,

Use Park's transformation and per unit system for simulation and stability analysis of power system.

Understand the general construction and relationship between the various fluxes and its impact on induced emf during the small and transient disturbances.

Understand the operational behavior and problems of two machine and multi-machine power system for stability study

To obtain the equivalent circuit, its parameters and simulation model for various components including loads in power system for static and dynamic stability studies.

Simulation and analysis of Dynamics of synchronous generator connected to infinite bus or multi machine power system.

To develop analytical approach and program tools for testing transition processes in power system.

Find equivalent pi model, sending and receiving end power using circle diagram, efficiency & regulation of long transmission line and compare the same with medium and short transmission lines.

Find effective inductance under open and short circuit condition, draw per phase equivalent circuit of

three-phase transformers and compare complex ideal transformers with simple ideal transformer.

Analyze three phase armature currents, field current and different reactance's in d-q frame at different operating conditions.

Compare the static and dynamic loads and their performance at different frequencies and voltages.

Transform 3-phase quantities from a-b-c frame to d-q-o frame and vice-versa

UNIT-I: Synchronous Machine Modeling

Description of a Synchronous Machine: Basic Synchronous Machine parameters, Voltage generation, Open-circuit voltage, Armature reaction, Terminal Voltage, Power delivered by generator.

UNIT-II: Synchronous Machine Modeling

Per unit system and normalization: Equations of a synchronous machine: Stator circuit equations, Stator self, Stator mutual and stator to rotor mutual inductances, The Park's transformation, Flux-linkage equations, Voltage and current equations for stator and rotor in dq0 coordinates, Phasor representation, Steady state analysis, Transient & sub-transient analysis, Equivalent Circuits for direct and quadrature axes, Transient & sub-transient inductances and Time constants.

UNIT-III: Excitation and prime-mover controllers

Excitation system, excitation system modeling, excitation system–standard block diagram, prime mover control system, examples.

UNIT-IV: Transmission line Modeling&Load Modeling

Introduction, derivation of terminal V, I relations, waves on transmission lines, transmission matrix, lumped circuit equivalent, simplified models, complex power transmission (short line, radial line, long or medium lines).Basic load- modeling concept, static load models, dynamic load model, acquisition of load model parameters.

UNIT-V : Transformer modeling & the per unit system

Introduction, single phase transformer model , three phase transformer connection , per phase analysis, p.u. normalization, p.u. three phase quantities, p.u. analysis of normal system , regulating transformer for voltage & phase angle control.

Text Books:

1. Power System Analysis: Arthur R. Bergen, Vijay Vithal, Pearson Education Asia

2. Power System Control and Stability: Anderson P. M. and Fouad A. A., Galgotia Publications,(1981).

3. Generalized Theory of Machine: P. S. Bimbra, Vol. 2, Khanna Publishers (1987)

4. Power System Stability and Control: Kundur, P., McGraw Hill Inc., (1994).

Reference Books:

1. Power System Dynamics, Stability and Control: Padiyar K. R., Interline Publishing Private Ltd., Banglore (1998).

2. Power System Analysis Operation and Control: 3rd ed., A. Chakrabarti, S. Halder, PHI, Eastern Economy Edition.

PGIDC103T/PGPEPS103T

ADVANCE CONTROL THEORY

(Common to M.Tech CBCS IDC and M.Tech CBCS PEPS)

Course Objective:

To understand and analyse electromechanical systems by mathematical modeling.
To Determine Transient and Steady State behavior of systems using standard test signals.
To understand linear and non-linear systems for steady state errors, absolute stability and relative stability
To Identify and design a control system satisfying requirements..

Course Outcomes:

After the completion of this course, the students shall be able to:
Develop mathematical models of physical systems.
Design optimal controllers for physical systems including power electronic and power systems.
Analyze the issues related to the stability of automatic control systems.
Design complex nonlinear systems by linearizing them

Unit-I State Variable Analysis:

Diagonalization of state model, Computation of STM by Laplace transform, Cayley Hamilton Theorem and Canonical transformation method, Solution of state equation. Controllability, Observability and state variable feedback.

Unit-II Digital Control Systems:

Models of Digital control Devices, State description of Digital
processors and sampled continuous time plants, discretization of digital continuous time state equations, Solution of state difference equation, Stability By Bilinear Transformation & Jury's Test.

Unit-III

Controllability and observability tests for digital control systems, Stability of discrete time
Systems, Pulse transfer function and its realization, Stability improvement by state feedback, Pole-placement design and state observers.

Unit-IV Lyapunov Stability Analysis:

Basic concepts, Limit cycles, Stability definitions, Stability Theorems, Lyapunov functions for linear and non-linear systems.

Unit-V Optimal Control:

Parameter optimization techniques, Lagrange parameter techniques, Calculus of variations, Unconstrained and Constrained minimization of functional, Two point boundary value problems, Pontrygin's minimum principle, Optimal regulator and tracking problems, Optimal digital control systems.

Reference Books

1. M.Gopal.; Digital Control and State Variable Methods; Tata McGraw Hill, New Delhi, 1997.
2. D.E. Kirk.; Optimal Control Theory; Prentice Hall, 1970.
3. M.Gopal.; Digital Control Engineering; Wiley Eastern, 1988.
4. B.C. Kuo.; Digital Control System Engineering; Saunders College publishing, 1992

5. Advanced Control System ,First Edition, M. Rihan

PGIPS104T/PGPEPS104T Elective I-(1)

Power System Dynamics and Control

(Common to M.Tech CBCS PEPS and M.Tech CBCS IPS)

Course Objective:

To provide in-depth understanding of operation of power flow studies in power system.

To examine topical issues of stability study due to various faulty conditions.

To enable students to analyze various types of methods to improve stability in integrated power systems.

Course Outcome:

After the completion of this course, the students shall be able to,

To understand short circuit and stability studies of components of power system.

To understand controls for improvement in transient stability.

To analyze the effects of various faults for multi machine systems.

To understand the role of advanced technologies to improve transient stability.

To study and analyze the Augmentation of stability

Unit-I Representation of Power System:

Elements like Synchronous machines, transformers, transmission lines, power semiconductor devices, loads, power system load flow, short circuit studies and power system stability studies using MATLAB-SIMULINK PSCAD, CAPS softwares.

Unit-II Transient Stability Problem:

Augmentation of Transient Stability by Discrete Supplementary Controls, Concept of resynchronization with discrete phase rotation for improvement in transient stability.

Unit-III Fault analysis of large power systems:

Transient stability – Review of classical methods, Dynamic and transient stability investigations and simulation of single machine infinite bus and multi-machine systems.

Unit-IV

Transient stability by step by step solution of swing equation, Euler's & modified Euler's method, Runga-kutta method, Transient state phasor diagram of synchronous machine.**Effects of various types of disturbances**, parameters and controls on stability, Effect of excitation control. Excitation system modeling, standard block diagram of excitation system.

Unit-V

Augmentation of stability by conventional methods, second swing instability, problems on salient pole synchronous generator. Effect of turbine governor control, simple block diagram,

Text Books:

1. Padiyar K.R.; Power System Dynamics, Stability and Control; B.S. Publications, Hyderabad 2002

2. Kimbark, E.W.; Power system stability, Vol. I & III, John Wiley & Sons, New York 2002
Stagg G.W. & El-Abiad A.H.; Computer Methods in Power System Analysis, McGraw Hill Co., Ltd., Tokyo

PGIPS104T/PGPEPS104T/PGIDC104T Elective I-(2)

Application of Microcontroller in Electrical System

(Common to M.Tech CBCS IDC ,M.Tech CBCS PEPS and M.Tech CBCS IPS)

Course Objective:

To understand Microprocessor types and its programming.
To understand various interfacing circuits necessary for various applications.
To understand various interfacing concepts.
To understand basic concepts of Microcontroller.

Course Outcome:

After the completion of this course, the students shall be able to,
Understand the causes, effects and remedies of power quality problems.
To design a system, component or process as per needs and specifications
To Write Assembly language program for 8051 Microcontroller to achieve solution to given task.
To learn functioning of Signal conditioning using specific circuits/ transducers and to measure electrical ornon-electrical quantities using processor.
To apply applications of microcontroller in various engineering fields.

Unit- I: Review of Microprocessor 8085/8086

Introduction To 16 Bit Microprocessors, 8086/8088 CPU Architecture,Memory Organization,Floating point arithmetic,Bus structure & timings,8086/8088 Instruction Set.

Unit-II: Microcontroller 8031/8051

Microcontroller: 8051 Architecture/ Pin Diagram,Special Function Register (SFR), Internal RAM/ROM, 8051 Instruction Set,Interrupts, Assembly Language Programming and their application,Interfacing to External Memory,Programming Techniques for looping, indexing,counting & bit manipulation,

Unit-III: Basic I/O Interfacing Concept

Memory mapped I/O programmable peripherals,I/O mapped I/O programmable peripherals,Introduction to PPI 8254/8255, Architecture,Modes of operation of 8255,Interfacing of peripherals with 8255,Introduction to PIC 8259, Architecture,Modes of operation of 8259,Interfacing of peripherals with 8259,Interfacing of keyboard & display ,ADC/DAC, USART.

Unit-IV: Interfacing of Microcontroller 8031/8051

Interfacing with ADC/DAC display, interfacing with Keyboard,Interfacing with LCD Display & Stepper Motor with 8251,Power factor improvements, Introduction to DSP processor & its application to power system, Generation of PWM signals using Timer/Counter. Harmonics analysis, FFT etc.

Unit-V: Microcontroller dsPIC33EP256MC202

Microcontroller: Architecture/ Pin Diagram, General Input/output ports, Control Registers for PPS, Interrupts, Oscillator, Timer, Generation of High Speed PWM. Applications to Motor Speed Control, AC-DC, DC-AC Conversion, Battery Charger, UPS, INVERTER, and Power factor Correction.

Text Books:

1. Hall: Microprocessor & Interfacing,: Programming & Hardware; Mc-Graw Hill Books.

2. Gaonkar: Microprocessor Architecture, programming Application with 8085,penram international publishing(India)

3. Texas Instruments DSPs.

4. Bhupendra Singh Chhabra: 8086/8088 Microprocessor Architecture Programming, Design & Interfacing, Dhanpat Rai & Sons.

   Ramakant Gaikwad: Op-amps & Linear IC's; Prentice Hall of India

5. Kenneth J. Ayala: The 8051 Microcontroller-Architecture, Programming & Application: penram international publishing(India)

6. Muhammad Ali Mazidi: The 8051 Microcontroller and Embedded Systems Using Assembly & C:Second Edition : Pearson Publication.

7. Data sheets of dspIC33EPMC202.

PGIPS104T/PGPEPS104T/PGIDC104T Elective I-(3)

Micro and Smart grid

(Common to M.Tech CBCS IDC ,M.Tech CBCS PEPS and M.Tech CBCS IPS)

Course Objectives:

To understand fundamental concepts of Microgrids, its Power Electronics Interface, protection and islanding issues

To understand various Power quality issues in Microgrid and introduction to smart grid technologies

To understand Renewable Energy and its storage options for smart grid technologies.

To understand smart grid measurement & communication Technology

Course Outcomes:

After the completion of this course, the students shall be able to:

Microgrid concepts, Power Electronics interface in AC & DC microgrids, Communication infrastructure, modes of operation and control, Protection and islanding issues, etc

Power quality issues in microgrids like modeling and stability analysis, regulatory standards and economics and basic smart grid concepts

Load and generation Power flow analysis, economic dispatch and unit commitment problems and various verticals of smart grid

Smart grid communication and measurement technologies like Phasor Measurement Unit(PMU),Smart meters, Wide Area Monitoring system(WAMS) etc

Penetration of Renewable Energy Sources in smart grid and associated issues and their applications in Electric vehicles etc

Unit-I: MICROGRIDS

Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids, communication infrastructure, modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques

Unit-II: POWER QUALITY ISSUES IN MICROGRIDS

Power quality issues in microgrids- Modeling and Stability analysis of Microgrid, regulatory standards, Microgrid economics, Introduction to smart microgrids.

Unit-III: INTRODUCTION TO SMART GRID

Basics of Power Systems: Load and Generation Power Flow Analysis, Economic Dispatch and Unit Commitment Problems, Smart Grid: Definition, Applications, Government and Industry, Standardization,Functions of Smart Grid Components-Wholesale energy market in smart grid-smart vehicles in smart grid.

Unit-IV: SMART GRID COMMUNICATIONS AND MEASUREMENT TECHNOLOGY

Communication and Measurement - Monitoring, Phasor Measurement Unit (PMU), Smart Meters, Wide area monitoring systems (WAMS)- Advanced metering infrastructure- GIS and Google Mapping Tools,IP-based Systems , Network Architectures

UNIT V - RENEWABLE ENERGY AND STORAGE

Renewable Energy Resources-Sustainable Energy Options for the Smart Grid-Penetration and Variability Issues Associated with Sustainable Energy Technology-Demand Response Issues-Electric Vehicles and Plug-in Hybrids-PHEV Technology-Environmental Implications-Storage Technologies-Grid integration issues of renewable energy sources.

Text books/Reference books:

1. James Momoh, "Smart Grid: Fundamentals of design and analysis", John Wiley & sons Inc, IEEE press 2012.

2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", John Wiley & sons inc, 2012.

3. Fereidoon P. Sioshansi, "Smart Grid: Integrating Renewable, Distributed & Efficient Energy", Academic Press, 2012.

4. Clark W.Gellings, "The smart grid: Enabling energy efficiency and demand response", Fairmont Press Inc, 2009.

PGPEPE201T/PGIPS201T

HVDC and FACTS

(High voltage DC and Flexible AC Transmission System)

(Common to M.Tech CBCS PEPS and M.Tech CBCS IPS)

Course Objectives:

To understand basics of HVDC Systems.
To understand convert control modes.
To understand filtering harmonics and ripple.
To enable the students to acquire a comprehensive knowledge on various aspects of FACTS systems.
To develop ability to implement FACTS controller.

Course Outcomes:

On completion of this course, the students shall be able to:
Describe types of topology and multi terminal HVDC System
Describe converter operation in various modes.
Describe converter control modes
Describe the application of filters to eliminates harmonics
Analyse the fault in HVDC system and provide proper protection.
Apply knowledge of FACTS controller to AC transmission system
Apply shunt, series and their combination for compensation.
Identify, formulate and solve network problems with FACTS controller.
Understand the basic requirements in AC transmission and limitations of AC transmission systems.
Understand the role of voltage, angle and impedance as important factors in AC power flow.
Understand the operating characteristic of various FACTS controllers and their role on enhancing maximum power transfer capacity of power transmission systems.
Understand the various methods of controlling voltage, angle and impedance in AC transmission system.
Establish skill to model and analyze FACTS devices in power transmission system operation.
Understand the causes, effects and remedies of power quality problems.

Unit I: HVDC Technologies

Developments in HVDC Technology, types of HVDC systems, equipments required for HVDC systems, comparison of HVDC system with AC systems in terms of technical performance, reliability of HVDC systems, comparison of HVDC link with EHVAC link, HVDC-VSC transmission systems.

Unit II: Rectifier and Inverter of HVDC systems

Rectifier and inverter operation, two valve, two/three valve, three/four valve operation, voltage current equations, control chart. Control techniques of HVDC converter and systems.

Unit III: Multi terminal HVDC system and FACTS

Multi terminal HVDC systems:Types, parallel operation, operation and control, control of power, faults and protection. Multi terminal networks for non conventional power sources. Flexible AC Transmission System (FACTS): Their role in power system, types of FACTS controller, principle of series and shunt controllers.

Unit IV: Shunt and series FACTS controllers

Shunt controllers: Objectives, static switched capacitor, Thyristor controlled rectifier and STATCOM. Serious controllers: Objectives, GTO thyristor controlled series capacitor, thyristor controlled series capacitor, thyristor controlled series compensators (TCSC), static synchronous series compensator (SSSC)

Unit V: Other FACTS controller

Working principle, control strategies and application of: Unified power flow controller (UPFC), interline power flow controller (IPFC)

Text / Reference Books:

1. S. Kamakshaiah, V. Kamaraju, "HVDC TRANSMISSION,"McGraw Hill Education (India) Private Limited, New Delhi, 2011

2. K. R. Padiyar, "HVDC POWER TRANSMISSION SYSTEMS,"New Age International Publishers, 2012

3. Narain G. Hingorani, Laszlo Gyugyi,"Understanding FACTS concept and technology of Flexible AC Transmission Systems,"IEEE PRESS, WILEY INDIA EDITION, 2000

4. K. R. Padiyar, "FACTS CONTROLLERS IN POWER TRANSMISSION AND DISTRIBUTION,"NEW AGE INTERNATIONAL PUBLISHERS, 2007

PGPEPS202T/PGIPS202T

Power Quality

(Common to M.Tech CBCS PEPS and M.Tech CBCS IPS)

Course Objectives:

To introduce various power quality events.
To introduce indices used for the analysis of power quality events.
To introduce mitigation techniques for the improvement of power quality.
To prepare student for analysis of power quality issues such as sag, flicker, harmonic distortion, unbalance, transients, etc.
To introduce students with some power quality mitigating techniques
To introduce the use power quality improvement methods.

Course Outcomes:

On completion of this course, the students shall be able to:
Identify the various power quality events like short and long duration variations, Waveform distortion,
Unbalance, Transients, Power factor etc.
Analyze the power quality issues using the Power quality indices.
Suggest suitable mitigation strategies for some of the power quality issues.
Provide solution for the mitigation of power quality issues like waveform distortion, unbalance, and poor power factor.
Analyze various power quality issues as sag, flicker, waveform distortion, unbalance, transients, etc.
Suggest suitable mitigation strategies for some of the power quality issues
Provide solution for the mitigation of power quality issues like harmonic distortion, unbalance, poor power factor.

UNIT-1: Introduction

Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Nonlinear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.

UNIT-2: Non Linear Loads

Single phase / Three phase static converters, Battery chargers, Arc furnaces, Fluorescent lighting, pulse modulated devices, Adjustable speed drives.

UNIT-3: Analysis and Conventional Mitigation Methods

Analysis of power outages, Analysis of unbalance: Symmetrical components of phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion: On– line extraction of fundamental sequence components from measured samples – Harmonic indices.

UNIT-4 : Voltage Sag

Analysis of voltage sag: Detorit Edison sag score, Voltage sag energy, Voltage Sag Lost Energy Index (VSLEI)- Analysis of voltage flicker, Reduced duration and customer impact of outages, Classical load balancing problem: Open loop balancing, Closed loop balancing, current balancing, Harmonic reduction, Voltage sag reduction.

UNIT-5: Power Quality Improvement

Utility-Customer interface –Harmonic filters: passive,–Custom power devices: Network reconfiguring Devices, Load compensation using DSTATCOM, Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC – control strategies: P-Q theory, Synchronous detection method – Custom power park – Status of application of custom power devices.

Text books:

1 Power Quality Enhancement Using Custom Power Devices 2002 ArindamGhosh Kluwer Academic Publishers

2 Electric Power Quality 1994(2nd edition) G.T.Heydt Stars in a Circle Publications

3 Power Quality Edition (Year of publication) R.C. Duggan

Reference books:

1 Power system harmonics A.J. Arrillga

2 Power electronic converter harmonics Derek A. Paice

PGPEPS203T

Advanced Electrical Drives

Course Objectives:

To understand various mechanical couplings, gears, flywheels used in drives and equivalent torque andinertia reflected on driving system.
To understand phase controlled and chopper controlled DC drives.

Course Outcomes:

After the completion of this course, students shall be able to:
Select the suitable drive for drive system such as phase angle controlled, chopper-controlled dc drive depending upon its rating.

UNIT –I Dynamics of Electric Drives:
Basic elements of an electric drives, Classification of electric drives, Stability consideration of electric drives.

UNIT–II: SINGLE-PHASE CONTROLLED RECTIFIERS FED DC 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.

UNIT–III: THREE-PHASE CONTROLLED RECTIFIERS FED DC MOTOR
Three-phase semi converter and Three phase full converter for continuous and discontinuous modes of operations – power and power factor - Addition of Free wheeling diode – Three phase double converter. 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.

UNIT–IV: 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 – Pulsating torque. **Closed loop operation:** Speed controlled drive system – current control loop – pulse width modulated current controller – hysteresis current controller – modeling of current controller – design of current controller.

UNIT–V: SIMULATION OF DC MOTOR DRIVES
Dynamic simulations of the speed controlled DC motor drives – Speed feedback speed controller – command current generator – current controller.

REFERENCES:

1. Power Electronics and motor control – Shepherd, Hulley, Liang – II Edition Cambridge University Press.

2. Electronic motor drives modeling Analysis and control – R. Krishnan – I Edition Prentice Hall India.

3. Power Electronics circuits, Devices and Applications – MH Rashid – PHI – 1 Edition 1995.

4. Fundamentals of Electric Drives – GK Dubey Narosa Publishers 1995

5. Power Semiconductor drives – SB Dewan and A Straughen -1975.

6.Bridges I. & Nasar S.A.; Electric Machine Dynamics Macmilan Publishing Company, NY,1986.

7. Krishnan, R.; Electric Motor Drives, Modelling, Analysis and Control; Prentice Hall India, 2003.

PGIDC204T/PGIPS204T/PGPEPS204T Elective III-(1)

Energy Audit and Management

(Common to M.Tech CBCS IDC , M.Tech CBCS PEPS and M.Tech CBCS IPS)

Course Objective:

To understand the present scenario of energy utilization, management and corresponding ACT of regulatory commission

To understand the process billing and power factor improvements to achieve energy efficient systems.

To understand role and responsibilities as energy auditors and energy manager in industrial applications.

Course Outcome:

After the completion of this course, the students shall be able to,

An ability to develop in depth knowledge for energy balance and understand the various acts for the same

To carry out energy audits for optimal use of energy.

An ability to understand billing process for various industrial applications and selection of the factors for better utilization of energy.

Understand energy conservation in thermal power station.

Carry out performance analysisof electrical appliances and related case studies for improvement.

Unit-I- Energy Scenario:

Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance

Unit II- Energy Management & Audit:

Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit Instruments energy management, Roles and responsibilities of energy Manager and Accountability, Financial analysis techniques, Financing options, Energy performance contracts and role of ESCOs. Defining monitoring & targeting, Elements of monitoring & targeting, Data and information-analysis, Techniques energy consumption, Production, Cumulative sum of differences.

Unit III-Energy Efficiency in Electrical system:
Electricity billing, Electrical load management and maximum demand Control, Maximum demand controllers; Power factor improvement, Automatic power factor controllers, efficient operation of transformers, Energy efficient transformers; Induction motors efficiency, motor retrofitting, energy efficient motors, Soft starters, Variable speed drives; Performance evaluation of fans and pumps, Flow control strategies and energy conservation opportunities in fans and pumps, Energy efficiency measures in lighting system, Electronic ballast, Occupancy sensors, and Energy efficient lighting controls. Factors affecting selection of DG system, Energy performance assessment of diesel conservation avenues

Unit IV:-Energy Conservation in Thermal Systems:
Types of boilers, Combustion in boilers, Performances evaluation, Feed water treatment, Blow down, Energy conservation opportunities in boiler, Properties of steam, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Identifying opportunities for energy savings. Classification, General fuel economy measures in furnaces, Excess air, Heat Distribution, Temperature control, Draft control, Waste heat recovery. Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria.Introduction, Mechanism of fluidized bed combustion, Advantages, Types of FBC boilers, Operational features, Retrofitting FBC system to conventional boilers, saving potential. HVAC system: Coefficient of performance, Capacity, Factors affecting Refrigeration and Air conditioning system performance and savings opportunities. Classification and Advantages of Waste Heat Recovery system, analysis of Waste heat recovery for Energy saving opportunities

Unit V: Energy Performance Assessment:
On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, Fans and pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method. Financial Analysis: simple payback period, NPV, IRR,

Text Books:

1. Handbook of Electrical Installation Practice. , By Geofry Stokes, Blackwell Science

2. Designing with light: Lighting Handbook., By Anil Valia, Lighting System

3. Energy Management Handbook., By W.C. Turner, JohnWiley and Sons

4. Handbook on Energy Audits and Management.Edited by Amit Kumar Tyagi, Tata Energy Research Institute (TERI).

5. Energy Management Principles., By C.B.Smith, Pergamon Press

6. Energy Conservation Guidebook., Dale R. Patrick, Stephen Fardo, Ray E.Richardson,Fairmont Press 7. Handbook of Energy Audits., By Albert Thumann,William J. Younger, Terry Niehus, CRC Press.

PGIDC204T/PGIPS204T/PGPEPS204T Elective III-(2)

Converters for Non Conventional Energy Sources

(Common to M.Tech CBCS IDC , M.Tech CBCS PEPS and M.Tech CBCS IPS)

Course Objective:

To introduce to students the importance of Advanced Power for conversion of power in various forms

To understand basic operation and control of pulse-width modulated inverters (PWM).

Course Outcome:

After the completion of this course, the students shall be able to,

An ability to develop in depth knowledge for WEC and PV based system.

An ability to develop in depth knowledge for analysis of grid connected WEC and PV system.

Able to understand the various power electronic converter topologies.

Able to use the basics of various converter topologies in the photovoltaic system operation.

Able to use the basics of various converter topologies in the wind energy conversion system.

UNIT- 1: Introduction

Wind Energy Conversion (WEC) system, Photovoltaic (PV) based Power conversion system. Introduction to converter in WEC and PV system.Modes of Operation of Converters; Grid Connection Mode, Stand-Alone Mode,Battery Charging Mode.

UNIT- 2: Analysis of Wind and PV Systems:

Standalone operation of fixed and variable speed wind energy conversion systems and solar PV system. Gridconnection Issues,operation of Grid integrated PMSG, SCIG and DFIG Based WECS.Grid Integrated solar PV system.

UNIT- 3: Converter Topologies

Topologies for two-Level Converter and three level converters. Modulation Strategies-Pulse WidthModulation, Carrier-Based Strategies, Space Vector Strategies.

UNIT- 4: Photovoltaic Inverter Structures

Inverter Structures Derived from H-Bridge Topology; Basic Full-Bridge Inverter, H5 Inverter (SMA), HERIC Inverter (Sunways), REFU Inverter Summary of H-Bridge Derived Topologies. Inverter Structures Derived from NPC Topology Neutral Point Clamped (NPC) Half-Bridge Inverter;NPC Inverter, Summary of NPC-Derived Inverter Topologies, Three-Phase PV Inverters, Control Structures, Conclusions and Future Trends.

UNIT-5: Converter Structures for Wind Turbine Systems

Introduction, WTS Power Configurations, Grid Power Converter Topologies; Single-Cell Voltage source converters, Multicell (Interleaved or Cascaded) converters and back to back converters, WTS Control; Generator-Side Control Grid side Control, Future trends in wind conversion system converters.

Text Books:

1. Modern Power Electronics by P.C. Sen AH Wheeler Publication
2. Power Electronics hand book By Rashid M.H. Academic Press
3. Non Conventional Energy Sources by G.D.Rai Khanna Publishers.
4. Grid Converter for Photovoltaic and Wind Power Systems by Remus Teodorescu,Marco Liserre, Pedro Rodr´ ıguez IEEE Press John Viley and Sons
5. Power Electronics Converter for Microgrids by Suleiman M. Sharkh, Mohammad A. Abusara, Georgios I. Orfanoudakis IEEE Press John Wiley and Sons
6. Power Electronics by Ned Mohan, Tora M. Udeland,William P. Robbins John Wiley and Sons
7. Non Conventional Energy Sources by B.H.Khan Mc Graw Hill

PGPEPS204T Elective III-(3)

Power System Planning

Course Objective:

To know power system planning, operation and management issues as well as reliability in the power sector.

The course will give a comprehensive overview of power system reliability. Evaluation ofgeneration, transmission and composite system reliability and their impacts on systemplanning will be covered

Course Outcome:

Understanding some advanced concepts of power planning.

Able to use the basics of load forecasting generation planning that will be useful for engineering professional practice in the power sector operation.

Able to use the basics of transmission planning that willbe useful for engineering professional practice in the power sector operation

Understanding concepts of power system reliability that will be useful for engineering professional practice in the power sector operation and planning.

Able to understand the System Operation & Environmental Aspects in Planning that will be useful for engineering professional practice in the power sector.

UNIT-1: Introduction

Introduction of power planning, National and Regional Planning, structure of P.S., planning tools, Electricity Regulation

UNIT-2: Load Forecasting & Generation Planning

Electrical Forecasting, forecasting techniques modeling. Generation planning, Integrated power generation cogeneration/captive power, Power pooling and power trading.

UNIT-3 : Transmission planning and Power System Economics

Transmission and distribution planning, Power system Economics, Power sector finance, financial planning, private participation Rural Electrification investment, concept of Rational tariffs.

UNIT-4: Reliability

Power supply Reliablity, Reliability planning, Reliability evaluation, Functional zones, Generation reliability, Generation & Transmission reliability, Quality of Supply.

UNIT-5 : System Operation & Environmental Aspects in Planning

System operation planning, load management, load prediction, reactive power balance, online power flow studies, state estimation, computerized management, power system simulator. Computer aided planning, wheeling, Environmental effects, Greenhouse effect, Technological impacts, Insulation coordination, Reactive compensation.

Text books:

1 Electrical Power System Planningby A.S.Pabla Macmillan India Ltd.

2 Power Generations, Operation & Control 2011 Allen J. Wood, B.F. Wollenberg Wiley India, Reprint

3 Modern Power System Analysis 4 th Edition D.P. Kothari, I.J. Nagrath Tata Mcgraw Hill Education Pvt. Ltd

PGOPEN 105T Open Elective II

Artificial Intelligence

(Open Elective II from Electrical Engineering Board)

Course Objectives:

To learn various types of algorithms useful in Artificial Intelligence (AI).
To convey the ideas in AI research and programming language related to emerging technology.
To understand the concepts of machine learning, probabilistic reasoning, robotics, computer vision, and natural language processing.
To understand the numerous applications and huge possibilities in the field of AI that go beyond the normal human imagination.

Course Outcomes:

After the completion of this course, the students shall be able to:
Design and implement key components of intelligent agents and expert systems.
To apply knowledge representation techniques and problem solving strategies to common AI applications.
Apply and integrate various artificial intelligence techniques in intelligent system
Development as well as understand the importance of maintaining intelligent systems.
Build rule-based and other knowledge-intensive problem solvers.

Unit 01: Introduction to Artificial Neural Network:

Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Historical Developments. Essentials of Artificial Neural Networks: Artificial Neuron Model, operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures

Unit 02: Classification Taxonomy of ANN:

Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules. Perceptron Models: Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem. Multilayer feed forward Neural Networks

Unit 03: Memory:

Associative Memory, Bi-directional Associative Memory (BAM) Architecture, BAM Training Algorithms: Storage and Recall Algorithm, BAM Energy Function, Self-Organizing Maps (SOM) and Adaptive Resonance Theory (ART).

Unit 04: Introduction to Fuzzy Logic system:
Fuzzy versus crisp, fuzzy sets: membership function, Basic fuzzy set operations, properties of fuzzy sets, fuzzy relations. Fuzzy Control**,** Predicate logic (Interpretation of predicate logic formula, Inference in predicate logic), fuzzy logic (Fuzzy quantifiers, fuzzy Inference), fuzzy rule based system, defuzzification methods

Unit 05: Introduction to other intelligent tools:
Introduction to Genetic Algorithm: biological background, GA operators, selection, encoding, crossover, mutation, chromosome. Expert System: software architecture, rule base system.

Text Books:

1. Simon Haykin, "Neural Networks: A Comprehensive Foundation", 2nd Edition, Pearson Education

2. S. Rajsekaram, G. A. Vijayalaxmi Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms Synthesis & Applications", Practice Hall India

3. James A. Anderson, "An Introduction to Neural Networks", Practice Hall India Publication

4. Mohamed H. Hassoun, "Fundamentals of Artificial Neural Network", Practice Hall India

Reference books:

1. Kelvin Waruicke, Arthur Ekwlle, Raj Agarwal, "AI Techniques in Power System", IEE London U.K.

2. S. N. Sivanandam, S. Sumathi, S. N. Deepa, "Introduction to Neural Network Using MATLAB 6.0", Tata McGraw Hill

3. Jacek Zurada, "Introduction to Artificial Neural Network", Jaico Publishing House India

PGOPEN 105T Open Elective II

Utilization of Electrical Energy

(Open Elective II from Electrical Engineering Board)

Course Objective:

To understand the Illumination -Design of lighting scheme-sources of light
To understand the Drives-Suitability for different applications
To understand Electric Heating and Welding - Different methods.

Course Outcome:

To select their electric drive system based on application and availability of power source.
Apply power electronics technology in efficient utilization of electrical heating
Apply power electronics technology in efficient utilization of electrical welding
Create lighting system using illumination fundamentals and various illumination Technologies.
Analyze effective utilization of Power Electronic technologies in Electrical Traction.

UNIT-I ELECTRIC DRIVES:

Type of electric drives, choice of motor, starting and running characteristics, speed control, temperature rise, Particular applications of electric drives, Types of industrial loads, continuous, Intermittent and variable loads, load Equalization.

UNIT-II ELECTRIC HEATING:

Advantages and methods of electric heating, resistance heating, induction heating and dielectric heating.

UNIT-III ELECTRIC WELDING:

Electric welding, resistance and arc welding, electric welding equipment, comparison between A.C. and D.C. Welding.

UNIT-IV ILLUMINATION FUNDAMENTALS & VARIOUS ILLUMINATION METHODS:

Introduction, terms used in illumination, laws of illumination, polar curves, photometry, integrating sphere, sources of light. Discharge lamps, MV and SV lamps – comparison between tungsten filament lamps and fluorescent tubes, Basic principles of light control, Types and design of lighting and flood ighting.

UNIT-V ELECTRIC TRACTION:

System of electric traction and track electrification. Review of existing electric traction systems in India. Special features of traction motor, methods of electric braking-plugging rheostatic braking and regenerative braking, Mechanics of train movement. Speed-time curves for different services – trapezoidal and quadrilateral speed time curves. Calculations of tractive effort, power, specific energy consumption for given run, effect of varying acceleration and braking retardation, adhesive weight and braking retardation adhesive weight and coefficient of adhesion.

TEXT BOOKS:

1. J.B. Gupta, "Utilization of Electric Power and Electric Traction", Kataria & Sons publishers, Delhi, IX Edtion, 2004.

2. C.L. Wadhwa, "Generation, Distribution and Utilization of electrical Energy", New Age International (P) Limited Publishers, 3rd Edition, 2010.

REFERENCES:

1. N.V. Suryanarayana, "Utilization of Electrical Power including Electric drives and Electric traction", New Age International (P) Limited Publishers, 1st Edition,1994.

2. E. Open Shaw Taylor, "Utilization of Electric Energy", Orient Longman,1st Edition,1937.

PGOPEN 301T Open Elective IV

PLC & SCADA

(Open Elective IV from Electrical Engineering Board)

Course Objective:

To understand the present scenario of energy utilization, management and corresponding ACT of regulatory commission

Students should understand the role of automation to make the distribution system more smart, reliableand efficient. They should correlate this aspect with required modern technology of PLC basedcomponents and SCADA.

Students should deal with the all inclusive role of SCADA and PLC in real time application.

Course Outcome:

Students will take part in all sorts of PLC system.

Students will be in condition to deal with the problems of PLC programming.

They will find out the real time schedule of operation of advanced PLC function.

Students will be in condition to deal with various PLC application.

They will handle the problems related with automation and SCADA

.

Unit 01: Introduction to PLC

Role of automation in Industries, benefits of automation, Necessity of PLC, History and evolution of PLC, Definition, types, selection criterion, Overall PLC system, PLC Input and output modules (along with Interfaces), CPU, programmers and monitors, power supplies, Solid state memory , advantages and disadvantages

Unit 02: Programming of PLC

Programming equipment, Various techniques of programming, Ladder diagram fundamentals, proper construction of ladder diagram, basic components and their symbols in ladder diagram, MCR (master control relay) and control zones, Boolean logic and relay logic Timer and counter-types along with timing diagrams, shift registers, sequencer function, latch instruction Arithmetic and logical instruction with various examples

Unit 03: Advance PLC function

Input ON/OFF switching devices, Input analog devices, Output ON/OFF devices, Output analog devices, programming ON/OFF Inputs to produce ON/OFF outputs. Analog PLC operation, PID control of continuous processes, simple closed loop systems, problems with simple closed loop systems, closed loop system using Proportional, Integral & Derivative (PID), PLC interface, and Industrial process example.

Unit 04: Applications of PLC

PLC interface to various circuits : Encoders, transducer and advanced sensors (Thermal, Optical, Magnetic, Electromechanical, Flow, Level sensors) Measurement of temperature, flow, pressure, force, displacement, speed, level Developing a ladder logic for Sequencing of motors, Tank level control, ON OFF temperature control, elevator, bottle filling plant, car parking Motors Controls: AC Motor starter, AC motor overload protection, DC motor controller, Variable speed (Variable Frequency) AC motor Drive.

Unit 05: SCADA Systems:

Introduction, definitions and history of Supervisory Control and Data Acquisition, typical SCADA system Architecture, Communication requirements, Desirable Properties of SCADA system, features, advantages, disadvantages and applications of SCADA. SCADA Architectures (First generation - Monolithic, Second generation - Distributed, Third generation – Networked Architecture), SCADA systems in operation and control of interconnected power system, Power System Automation (Automatic substation control and power distribution), Petroleum Refining Process, Water Purification System, Chemical Plant. Interfacing of SCADA with PLC.

Text Books:

1. Gary Dunning, “Introduction to Programmable Logic Controllers”, Thomson, 2nd Edition

2. John R. Hackworth, Frederick D., Hackworth Jr., “Programmable Logic Controllers Programming Methods and Applications”, PHI Publishers

3. John W. Webb, Ronald A. Reis, “Programmable Logic Controllers: Principles and Application”, PHI Learning, New Delhi, 5th Edition

4. Ronald L. Krutz, “Securing SCADA System”, Wiley Publications.

5. Stuart A Boyer, “SCADA supervisory control and data acquisition”, ISA, 4th Revised edition

6. Sunil S. Rao, “Switchgear and Protections”, Khanna Publications.

7. L.A. Bryan, E. A. Bryan, “Programmable Controllers Theory and Implementation” Industrial Text Company Publication, Second Edition

Reference books:

1. Batten G. L., “Programmable Controllers”, McGraw Hill Inc., Second Edition
2. Bennett Stuart, “Real Time Computer Control”, Prentice Hall, 1988
3. Doebelin E. O., “Measurement Systems”, McGraw-Hill International Editions, Fourth Edition, 1990
4. 4. Gordan Clark, Deem Reynders, “Practical Modern SCADA Protocols”, ELSEVIER
5. Krishna Kant, “Computer Based Industrial Control”, PHI
6. M. Chidambaram, “Computer Control of Process”, Narosha Publishing
7. P. K. Srivstava, “Programmable Logic Controllers with Applications”, BPB Publications
8. Poppovik, Bhatkar, “Distributed Computer Control for Industrial Automation”, Dekkar Publications
9. S. K. Singh, “Computer Aided Process Control”, PHI
10. Webb J. W, “Programmable Controllers”, Merrill Publishing Company, 1988

PGOPEN 301T Open Elective IV

Digital Control System

(Open Elective IV from Electrical Engineering Board)

Course Objective:

The course will develop the capability of analyzing the stability of a system and of designing simplecontrollers to regulate system behavior.

The course will introduce different optimization techniques to achieve desired performance.

The course will give an idea about digital controller and technique for stability analysis of Digital Control System.

Course Outcome:

Students will be able to analyze discrete time control system and signals

Students will be able to derive and design various stability techniques for improving performance of the system

Students will be able to analyze continuous time system using state space technique.

students will be able to derive and describe pole placement by state variable technique and condition for controllability and observability of the system

Students will be in condition to deal with various Digital control system applications.

Unit 01: Discrete systems and Signals

Standard discrete test signals, Basic operations on signals. Classification of discrete systems. Detail analysis of frequency aliasing & quantization, Brief review of Sampling theorem, Ideal low pass filter. Transfer function of ZOH, Frequency domain characteristics of ZOH, First order hold, frequency domain characteristics of first order hold.

Unit 02: Stability Analysis

Brief review of pulse transfer function, mapping between S-plane and Z-plane, constant frequency loci and constant damping ratio loci. Stability analysis of closed loop system in the Z-Plane. Jury's stability test, Stability analysis by use of Bilinear transformation & Routh Stability Criterion. Digital compensator design using frequency response (Bode plot).

Unit 03: State - Space analysis

Conversion of Pulse transfer functions to State space model and vice a versa. Solution of LTI Discrete –time state equation; State Transition Matrix (STM) and properties of STM; Computation of STM by Z-transform method, by power series expansion method, by Cayley Hamilton theorem, by Similarity transformation method, Discretization of continuous time state space equation.

Unit 04: Design using state space

Controllability and observability of linear time invariant discrete-data system, Tests for Controllability and obervability; Principal of Duality; Effect of pole- zero cancellation; Relationship between controllability, observability and stability. Pole placement design using linear state-feedback. State estimation and full order observer design. Ackermann's formula.

Unit 05: Digital control system applications

Hybrid system simulation, Computer program structure for simulation of discrete time control of continuous time plant. Digital temperature control, position control, Stepper motor control, Block diagram presentation and control algorithms.

Text Books:

1. K. Ogata, "Discrete Time Control System", 2nd Edition, PHI Learning Pvt. Ltd. 2009

2. B. C. Kuo, "Digital Control Systems", 2nd Edition, Oxford University Press

3. M. Gopal, "Digital Control Engineering", New Age International Publishers

4. M. Gopal, "Digital Control and State Variable Methods", 3rd Edition The McGraw Hill Co.

Reference books:

1. Load D. Landau, Gianluca Zito, 'Digital Control Systems: design, Identification and Implementation' Springer.

2. Mohammed Santina, Allen Stubberud, Gene Hostetter 'Digital control System Design', Sanders College publishing.

3. K.J. Astrom, B Wittenmark 'Computer Controlled Systems: Theory and Design' Prentice-Hall Inc New Jersey , 2011 Dover .

PGFD205T Foundation Course -I

Research Methodology

Course objective:

1. Introduction to philosophy of research.
2. Understand process to formulate research questions / idea
3. Understand process of planning of research time, resource
4. Understand different statistical analysis methods
5. Develop thesis and report writing.

Course outcome:

1. Knowledge on various kinds of research questions and research designs
2. Formulate research problems (task) and develop a sufficiently coherent research design
3. Assess the appropriateness of different kinds of research designs
4. Knowledge on qualitative, quantitative and mixed methods of research, as well as relevant ethical and philosophical considerations
5. Develop independent thinking for critically analyzing research reports

Unit 1 Research Foundation

What is Research,Objectives of Research,Types of Research,Scientific Research,Research and Theory,Conceptual and theoretical Models,Importance of research methodology in scientific research

Unit 2 Review of Literature

Need for Reviewing Literature, What to Review and for what purpose, Literature Search Procedure, Sources of Literature, Planning of Review work, Note Taking, Library and documentation

Unit 3 Planning of Research

The planning process ,Selection of a Problem for Research,Formulation of the Selected Problems, Hypothesis formation,Measurement, Research Design/Plan

Unit 4 Processing of Data and Statistical Analysis of Data

Introduction to Statistical Software, MINITAB, SPSS, Measures of Relationship, Simple Regression Analysis, Multiple Correlation and Regression, Partial Correlation, MATLAB and Neural Network based optimization,Optimization of fuzzy systems, Error Analysis, Results and their discussions

Unit 5 Report and Thesis writing

Types of Reports, Planning of Report Writing, Research Report Format, Principles of Writing, Data and Data Analysis Reporting in a Thesis, Use of Endnote, Bibliography, API , appendix, table, Observations arrangement, Preparation of type script and lay-out of thesis, Use of LATEX Indexing of Journals, Impact factor and social Media for Researchers.

Reference Book:

1. Research Methodology: Methods and Techniques by C. R. Kothari, New Age International Publishers, ISBN:81-224-1522-9

2. Statistical Methods for Research Workers by Fisher R. A., Cosmo Publications, New Delhi ISBN:81-307-0128-6

3. Design and Analysis of Experiments by Montogomery D.C. (2001), John Wiley, ISBN: 0471260088

4. MINITAB online manual

5. Methodology of Research in Social Sciences by O. R. Krishnaswamy and M. Rangnatham Himalaya publication House, 2005, ISBN: 8184880936

6. SPSS online manual

PGFD302T Foundation Course -II

Project Planning and Management

Project Management (PM) will provide students with the opportunity to gain a systematic and comprehensive understanding of key concepts and skills essential to project management in international affairs. By examining the project cycle using potential projects, students will learn techniques and tools used in formulating and managing projects and programs for desired impact.

By course end, students will be familiar with aid and development of project works, language and terminology used, different project structures, implementation practices, and strategies to address potential conflicts and obstacles. More importantly, students will have developed skills - strategic design, needs assessment, implementation, proposal and report writing, budgeting, monitoring and evaluation, advocacy, and others - that practitioners need to be effective in a range of professional contexts.

Course Philosophy: This is a course that will utilize learning techniques to provide students with opportunities to practice and process what they learn. This course attempts to cover skills that are relevant and current in international program work.

Learning Objectives: By course end students will be able to, within the above-stated limitations:

1. Conduct a basic needs assessment for a proposed project
2. Develop a project proposal
3. Develop a logical framework
4. Develop measureable indicators
5. Have ability to insert Monitoring and Evaluation into a project
6. Develop a grant proposal
7. Develop a project budget

As part of comprehensive preparation for the subject, by end of semester students will prepare an analytical and operational concept note that demonstrates:

1. Comprehensive understanding of the *context* in which they will work, including socio-political, economic, and cultural aspects.
2. Understanding of the *issue* they will work on, the causes, and its variations across contexts.
3. Strategies that have been used to tackle the problem(s) - the usual ones, and innovative ones. Students can introduce also other possible solutions worth exploring.

Benefits

- Establish measures of success
- Quantify value commensurate with cost
- Optimize use of organizational resources
- Incorporate quality principles

- Put strategic plans into practice
- Ensure fast time-to-market Project Manager
- Reduced cost to deliver solutions
- Lower risk of slipping schedule
- Repeatable successes on projects
- Crisis prevention
- Early problem identification and risk mitigation
- Structured approach to Project Management
- More predictable results
- Improved resource productivity and satisfaction
- Project success that builds business success

Course Contents

Unit 1 : ***Basics of Project Management:***

Introduction, Need for Project Management, Project Management Knowledge Areas and Processes, The Project Life Cycle, The Project Manager (PM), Phases of Project Management Life Cycle, Project Management Processes, Impact of Delays in Project Completions, Essentials of Project Management Philosophy, Project Management Principles

Unit 2 : Project Identification and Selection:

Introduction, Project Identification Process, Project Initiation, Pre-Feasibility Study, Feasibility Studies, Project Break-even point ***Project Planning:*** Introduction, Project Planning, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS) ***Organisational Structure and Organisational Issues:*** Introduction, Concept of Organisational Structure, Roles and Responsibilities of Project Leader, Relationship between Project Manager and Line Manager, Leadership Styles for Project Managers, Conflict Resolution, Team

Unit 3: Resources Considerations in Projects:

Introduction, Resource Allocation, Scheduling, Project Cost Estimate and Budgets, Cost Forecasts ***Project Risk Management:*** Introduction, Risk, Risk Management, Role of Risk Management in Overall Project Management, Steps in Risk Management, Risk Identification, Risk Analysis, Reducing Risks

Unit 4 : ***Project Quality Management and Value Engineering:***

Introduction, Quality, Quality Concepts, Value Engineering ***Project Management Information System:*** Introduction, Project Management Information System (PMIS), Planning of PMIS, Design of PMIS ***Purchasing and Contracting for Projects:*** Introduction, Purchase Cycle, Contract Management, Procurement Process

Unit 5 : ***Project Performance Measurement and Evaluation:***

Introduction, Performance Measurement, Productivity, Project Performance Evaluation, Benefits and Challenges of Performance Measurement and Evaluation, Controlling the Projects ***Project Execution and Control:*** Introduction, Project Execution, Project Control Process, Purpose of Project Execution and Control ***Project Close-out, Termination and Follow-up:*** Introduction, Project Close-out, Steps for Closing the Project, Project Termination, Project Follow-up ***Project Management Software:*** Introduction, Advantages of Using Project Management Software, Common Features Available In Most of the Project Management Software, Project 2000.

Reference Books:

1. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, by John W. Creswell, 2nd Edition , Sage Publication, 2003

2. Qualitative Inquiry and Research Design: Choosing among Five Approaches, by John W. Creswell, 3rd Edition , Sage publication, 2013.

3. Evaluation: A Systematic Approach, Peter H. Rossi, Mark W. Lipsey, and Howard E. Freeman, 7th edition , Sage publications, 2007.

4. Handbook of Practical Program Evaluation, Joseph S. Wholey, Harry P. Hatry, Kathryn E. Newcomer. 4th edition, Wiley, 2015

5. Program Evaluation and Performance Measurement: An Introduction to Practice, James C. McDavid and Laura R. L. Hawthorn, Sage Publication, 2013.

6. Evaluation, Carol H. Weiss, 2nd Edition, ABE books, 1997.

7. Case Study Research: Design and Methods, Robert K. Yin, 3rd Edition, Sage Publications, 2011

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