SHRI RAMDEOBABA COLLEGE OF ENGINEERING AND MANAGEMENT, NAGPUR

An Autonomous College of Rashtrasant Tukadoji
Maharaj Nagpur University, Nagpur, Maharashtra (INDIA)

TEACHING SCHEME & SYLLABUS
2016-17

M. TECH. POWER ELECTRONICS
AND POWER SYSTEM

Published by
Dr. R.S. Pande
Principal
Shri Ramdeobaba College of Engineering & Management
Ramdeo Tekdi, Gittikhadan, Katol Road, Nagpur - 440 013
Ph. : 0712-2580011 Fax : 0712 - 2583237
ISO 9001 : 2008 CERTIFIED ORGANISATION

M. TECH. POWER ELECTRONICS AND POWER SYSTEM

Shri Ramdeobaba College of Engineering & Management, Nagpur

About the department

The Department of Electrical Engineering was established in year 1984 with a sanctioned UG intake of 60 students. The National Board of Accreditation has accredited the program thrice in succession in the years 2001, 2006 & 2012. Presently, the Electrical Engineering Department is also running a PG program (M. Tech. in Power Electronics & Power Systems) with sanctioned intake of 18, started from 2011. It is a Recognized Research Centre, approved by RTM Nagpur University for Master of Engineering (M.E by Research) and Doctoral program and has Thirteen well-equipped laboratories.

The department has two Professors, ten Associate Professors and eleven Assistant Professors on the roll. It has well qualified and experienced faculty with industrial background. They have undertaken many consultancy projects and have been granted patent by Government of India.

The department has conducive environment for the academic and overall development of the students. The Electrical Engineering Students Association (EESA) is a platform for promoting the curricular, co-curricular and extracurricular students activities. Department students actively participate in sports and represent the college at various levels. Students are keenly interested in contributing for social cause and join the National Service Scheme (NSS) activities. The department organizes Seminars, Guest lectures and Training programs, Product exhibitions for the students. Students get opportunity to enhance their technical skill by participating in the training program like PLC and SCADA.

To introduce the graduating students to the latest developments in industry, the department has organized product exhibition “Empower-2012” and “Empower-2013”. Reputed companies namely ABB Limited, ARCTIC Infra Tech Solutions Ltd., Larsen and Toubro Switchgear Ltd, HOIKI Inc. Japan, GRANDSTREAM INDIA Cohesive Technologies (P) Ltd, Grondfos Pumps India Private Ltd, Hager Electro Private Limited, KEI Industries Limited, Powerica Ltd. (Cummins Division), WIPRO Lighting, Texas Instruments, Bergen Associates, Schneider Electrical, HP India, Biosys (India PVT Ltd), Rockwell Automation participated in the exhibition with the wide range of products to display.

The department has excellent placement record. Students are placed in core electrical as well as IT companies. Companies visiting the campus for the placement include: Reliance Energy, L&T, Mahindra & Mahindra, and Kirloskar Oil Engines, BILTs, TCS, Tech-Mahindra, Syntel, Mindtree, Raymond Limited, Shapoorji Pallonji, Infosys, EMCO PVT Ltd. and many more.

On academic front, the department results are consistently good. It has active Entrepreneur Development Cell to develop the entrepreneurial skills among the students. The department highly encourages the industry interaction. Students go for industry training during the vacation.

Department Vision: The department of electrical engineering endeavors to be one of the best departments in India having expertise to mould the students to cater the needs of society in the field of technology, leadership, administration, ethical and social values.

Department Mission: To provide dynamic and scholarly environment for the growth and development of students and the Institution at large, by synergetic efforts of all stake holders of the Electrical Engineering department.

Programme Educational Objectives

PEO1. To mould the students to improve their technical and intellectual capability in Power Electronics & Power System and to develop interest for life-long learning.

PEO2. To prepare the students to acquire the knowledge, skills, qualities and values necessary for employment in areas related with Power Electronics & Power System.

PEO3. To prepare and inspire the students to become future researcher/good teacher/technocrat/ with innovative idea for sustainable development.

Programme Outcomes

After completion of the programme, the students will be able to,

PO 1. Acquire knowledge of Power Electronics and Power System with an ability to analyze and correlate the available knowledge with own work.

PO 2. Analyze critically the complex problems in the area of Power Electronics and Power Systems.

PO 3. Solve problems satisfactorily in the field of Power Electronics and Power System and arrive at appropriate solution.

PO 4. Explore information through literature survey and prepare a research plan for a problem or topic to investigate to arrive at appropriate solution or conclusion.

PO 5. Learn modern engineering simulation tools & equipments and apply them in the area of Power Electronics and Power System.

PO 6. Perform multidisciplinary work for scientific research.

PO 7. Demonstrate knowledge of project management principles to execute project with due consideration of economical and financial factors.

PO 8. Communicate with the engineering community regarding complex engineering activities by writing effective reports and making effective presentations.

PO 9. Engage in self-study and life-long learning with a high level of enthusiasm and commitment to improve knowledge and competence.

PO 10. Understanding of professional and ethical responsibility.

PO 11. Examine critically the outcomes of one's actions, make corrective measures subsequently, and learn from mistakes without depending on external feedback.

Scheme of Examination of Master of Technology (Power Electronics and Power System)
Semester Pattern

I Semester, M. Tech. (Power Electronics and Power System)

Sr. No.	Code	Course	L	P	Credits	Maximum Marks: Continuous Assessment	Maximum Marks: End Sem	Maximum Marks: Total	Exam Duration	Category
1.	EET551	Advanced Power Electronics	4	0	4	40	60	100	3 Hrs.	PC
2.	EEP551	Advanced Power Electronics Lab.	0	2	1	25	25	50		PC
3.	EET552	Power System Modeling & Analysis	4	0	4	40	60	100	3 Hrs.	PC
4.	EET553	Research Methodology	3	0	3	40	60	100	3 Hrs.	FC
5.	EET554	Processor Applications in Power System	4	0	4	40	60	100	3 Hrs.	PC
6.	EEP554	Processor Lab.	0	2	1	25	25	50		PC
7.	EEP555	Simulation Lab.	0	4	2	25	25	50		FC
8.	EET556	FACTS & HVDC Transmission	4	0	4	40	60	100	3 Hrs.	PC
		Total	**19**	**8**	**23**			**650**		

PC = Program Core, PE = Program Elective, FC = Foundation Course,
GE = Group Elective, OE = Open Elective

II Semester, M. Tech. (Power Electronics and Power System)

Sr. No.	Code	Course	L	P	Credits	Maximum Marks: Continuous Assessment	Maximum Marks: End Sem	Maximum Marks: Total	Exam Duration	Category
1.	EET557	Advanced Drives	4	0	4	40	60	100	3 Hrs.	PC
2.	EEP557	Advanced Drives Lab.	0	2	1	25	25	50		PC
3.	EET558	Advanced Power System Protection	4	0	4	40	60	100	3 Hrs.	PC
4.	EEP559	Energy Audit Lab.	0	2	1	25	25	50		PC
5.	EET560-X	Program Elective - I	4	0	4	40	60	100	3 Hrs.	PE
6.	EET561	Group Elective	4	0	4	40	60	100	3 Hrs.	GE
7.	EET599	Open Elective	3	0	3	40	60	100	3 Hrs.	OE
		Total	**19**	**4**	**21**			**600**		

PC = Program Core, PE = Program Elective, FC = Foundation Course,
GE = Group Elective, OE = Open Elective

Program Elective -I	
EET560-1	Power Quality
EET560-2	Digital Signal Processing

Open Elective	
EET599	Energy Management System

Group Elective	
EET561	Electrical Power Distribution & Smart Grid
ENT560	VLSI Design Automation
CST575-1	Optimization Techniques in Artificial Intelligence
CST575-2	Social Network Analysis

III Semester, M. Tech. (Power Electronics and Power System)

Sr. No.	Code	Course	L	P	Credits	Maximum Marks			Exam Duration	Category
						Continuous Assessment	End Sem	Total		
1.	EET651-X	Program Elective II	4	0	4	40	60	100	3 Hrs.	PE
2.	EET652-X	Program Elective III	4	0	4	40	60	100	3 Hrs.	PE
3.	EEP653	Circuit Simulation & Hardware Implementation Lab.	0	4	2	25	25	50	-	PC
4.	EEP654	Project Phase - I	-	3	6	100	100	200		Project
		Total	**8**	**9**	**16**			**450**		

PC = Program Core, PE = Program Elective, FC = Foundation Course,
GE = Group Elective, OE = Open Elective

Program Elective - II	
EET651-1	Microcontroller Applications in Power Controllers
EET651-2	Electric Vehicles
EET651-3	Renewable Power Generation Sources

Program Elective - III	
EET652-1	Power System Dynamics & Control
EET652-2	Advanced Control System
EET652-3	Industry offered elective

IV Semester, M. Tech. (Power Electronics and Power System)

Sr. No.	Code	Course	L	P	Credits	Maximum Marks			Exam Duration	Category
						Continuous Assessment	End Sem	Total		
1	EEP655	Project Phase - II	-	6	12	200	200	400	-	Project
		Total	**-**	**6**	**12**	**-**	**-**	**400**	**-**	

Total credits = 72; Total Marks = 2100

M.Tech (PEPS) Semester - I

ADVANCED POWER ELECTRONICS

Course Code: EET551 **Total Credits: 04**

L: 4 hrs, P: 0 hrs. per week

Course Objectives:

1. To understand the characteristics, capabilities, ratings, limitations and testing of various power semiconductor switches used for various Power Electronic applications.
2. To understand the performance and design of low frequency switched and high frequency switched AC to DC, AC to AC, DC to DC and DC to AC power electronic converters for various applications.
3. To understand the analysis of high frequency switched converters.

Course Outcomes:

After completion of this course, students shall be able to

CO1. : Select semiconductor switches for various power electronics converters.

CO2. : Analyze operation of DC-DC, AC-DC and SMPS power supplies.

CO3. : Analyze operation of Two level and Multilevel Inverter.

CO4. : Understand the harmonics in Inverter and harmonics reduction techniques.

CO5. : Design protection circuit and magnetic components required in power electronics converters.

Syllabus:

Overview of power semiconductor devices: SCR, Triac, BJT, IGBT, MOSFET, GTO, their turn-on and turn-off methods characteristics, protection and their applications.

Phase angle controlled converters: Phase angle AC-DC and AC to AC converters dual converters, chopper converters, Cycloconverters and their applications. Multiphase converters.

Switched mode converter: Various topologies of SMPS / DC-DC PWM Converters, AC to DC PWM converters: Buck, boost, buck-boost, Cuk and full-bridge dc–dc converters high power factor converter and their applications.

Soft switching converter: Working principles, topologies and analysis of resonant converters, Quasi-resonant converters and applications.

Inverters: Single phase and three phase inverters, voltage and current source Inverters, Harmonic reduction, UPS, Multilevel Inverter: principles, topologies, control and applications

Design of Magnetic components: Inductor, HF transformer, line and EMI fitter.

Protection of semiconductor devices: Over voltage, over current, dv/dt and di/dt.

Text books:
1. Power Electronics, circuit, Devices and applications: Rashid M.H., Prentice Hall of India.
2. Power Electronics Principles and Applications: Joseph Vithyathil, Tata Mcgrawhill edition.

Reference Books:
1. Power Electronics converters, Application and Design: Mohan N. Underland TM, Robbins WP., John Wiley & Sons.
2. Modern Power Electronics: P. C. Sen
3. Power Electronics and AC Drives: B. K. Bose, Prentice Hall, NJ, (1985).
4. Related IEEE papers/ NPTEL lectures

ADVANCED POWER ELECTRONICS LAB.

Course Code: EEP551 **Total Credits: 01**
L: 0 hrs, P: 2 hrs. per week

Course Objectives:
1. To make students conversant with characteristics of various power semiconductor switches e.g. Power MOSFET, IGBT, SCR, Traic etc.
2. To make student capable of using state of the arts test equipments e.g. Digital Storage Oscilloscope, Power Quality Analyser, Hall Effect Transducer etc.
3. To understand the various conversion techniques of AC to DC converter using phase angle & PWM control methods & its effect on power quality & power factor.
4. To understand the conversion of fixed AC to variable AC voltage & frequency.

Course Outcomes:
After the completion of this course, the students will be able to,

CO1. Test power semiconductors switches & converters and select suitable switch for particular applications.
CO2. Handle and use important test equipments e.g. Power Quality Analyzer & DSO etc.
CO3. Analyse input supply parameters while using different types of converters.
CO4. Use particular configuration of converter and inverters depending upon the availability of power supply & load requirement.

Contents:
Experiments based on,
- Characteristics of semiconductor switches.
- Various types of AC & DC converters & their wave forms.
- Performance parameters of AC to AC, DC- DC & DC- AC converters

Text books:
1. Power Electronics, circuit, Devices and applications: Rashid M.H., Prentice Hall of India.
2. Power Electronics Principles and Applications: Joseph Vithyathil, Tata McGraw Hill.

Reference Books:
1. Power Electronics converters, Application and Design: Mohan N. Underland TM, Robbins WP., John Wiley & Sons.
2. Modern Power Electronics: P. C. Sen
3. Power Electronics and AC Drives: B. K. Bose, Prentice Hall, NJ, (1985).

POWER SYSTEM MODELLING & ANALYSIS

Course Code: EET552 **Total Credits: 04**

L: 4 hrs, P: 0 hrs. per week

Course Objectives:

1. To understand modeling of long transmission line with their analysis and compare the same with medium and short transmission lines.
2. To understand the concepts of load flow as steady state solution compare various methods of load flow.
3. To understand modeling of single phase transformer and three phase transformer with it's per phase equivalent circuit.
4. To understand simple mathematical model of synchronous machine under all conditions in per unit analysis.
5. To understand AC & DC excitation system, basic load modeling concepts and mathematical modeling of Induction motor.

Course Outcomes:

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

CO1. 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.

CO2. Apply the different Load Flow Techniques to given Power System and analyse the given system for security studies.

CO3. Find effective inductance under open and short circuit condition, draw per phase equivalent circuit of three-phase transformer.

CO4. Analyze three phase armature currents, field current and different reactances in d-q frame at different operating conditions.

CO5. Analyze transfer functions/ gains of AC & DC excitation system.

CO6. Compare the static and dynamic loads and understand the concept of mathematical modeling of induction motor.

Syllabus:

Synchronous Machine Modeling: Basic models, Electrical equations, Mechanical equations, Per Unit System and Normalization, 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, P-δ curves for steady and transient state, Transient & sub-transient inductances and Time constants, Simplified models of synchronous machines. Synchronizing generator to an infinite bus.

Transmission line 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) and their analysis, power circle diagram for short line.

Load Flow Analysis: Network modeling, Formation of Y Matrix, Load flow-Newton Raphson, Gauss-Siedel, Fast decoupled method, Sparsity technique, Comparison of GS, NR & FDC methods, Review of AC/DC load flow solutions.

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.

Excitation system & load modeling: Excitation system and its modeling, excitation system –standard block diagram, system representation by state equations, Basic load- modeling concept, static load models, dynamic load model.

Modeling of 3-phase Induction Motor: a-b-c- to d-q-o transformation, Dynamic analysis in terms of stator –d-q windings and rotor d-q windings, Electromagnetic torque equation.

Text books:

1. Power System Analysis: Arthur R. Bergen, Vijay Vithal, Pearson Education Asia
2. Generalized Theory of Machine: P. S. Bimbra, Vol. 2, Khanna Publishers (1987)
3. Power System Stability and Control: Kundur, P., McGraw Hill Inc., (1994).
4. Power System Control and Stability: Anderson P.M. and Fouad A.A., Galgotia Pub. ,(1981).
5. Analysis of Electric Machinery, Krause P. C. TMH, New Delhi, Latest Edn.

Reference Books:

1. Power System Dynamics, Stability and Control: Padiyar K. R., Interline Publishing Private Ltd., Bangalore (1998).
2. Power System Analysis Operation and Control: 3rd ed., A. Chakrabarti, S. Halder, PHI, Eastern Economy Edition
3. Related IEEE papers/ NPTEL lectures.

RESEARCH METHODOLOGY

Course Code: EET553 **Total Credits: 03**

L: 3 hrs, P: 0 hrs. per week

Course Objectives:

1. To introduce the concept of engineering research including selection of problem, literature review, hypothesis, research methodology, professional ethics, environmental considerations and criteria for good research.
2. To introduce various aspects of technical paper writing, report writing, audio-visual presentation and data presentation skills.
3. To introduce the importance of intellectual property rights.

Course Outcomes

On completion of this course, the students will be able to,

CO1. Plan a research process applicable to electrical engineering.

CO2. Conduct literature survey and write a technical paper.

CO3. Use software tool to simulate electrical systems and analyze the performance.

CO4. Communicate effectively the research/review findings by audio-visual presentation.

CO5. Understand plagiarism in research and methods for avoiding it.

CO6. Understand various aspects of patents.

Syllabus

General Aspects of Research: Meaning, motivation, characteristics, general objectives and types of research, difference between research technique, research method and research methodology, criteria for good research.

Research Problem: Defining & selection of research problem, method of selecting the research problem, research process in general & in electrical engineering, setting objectives for research, industry/ site visits, preparation of research plan/ design.

Literature Review: Significance and procedure of literature review, types of literature, current areas of research in electrical engineering, Standard national and international journals in electrical engineering, sources, environmental aspects in electrical engineering research.

Hypothesis: Construction, Functions, Types and Errors in testing of Hypothesis.

Technical Paper Writing, Technical Thesis Writing and Power Point Presentation: Necessities of good technical paper, paper format, approach towards writing different components of technical paper, Do's and Dont's in paper writing, concept of bibliography/ references, Writing the Synopsis prior to final report, considerations in technical report writing, Effective power point presentation on technical research.

Data Presentation Skills: Histogram, bar charts, pie charts, 2D & 3D plots, interpolation & extrapolation, curve-fitting, FFT.

Artificial Intelligence Methods: Basics of Expert System, Fuzzy Logic, ANN & applications in electrical engg.

Computer Simulation Tools: MATLAB, Simulink, PowerSim, and their applications in electrical engineering.

Experimental tools & components: Sensors, study of data sheets for various components such as linear IC, digital IC, driver circuits and electrical elements.

Evaluation of Research: Intellectual property rights, journal rankings, impact factor, eigenfactor score, citation, h-index and their calculation, plagiarism, IEEE levels of plagiarism, Avoiding plagiarism, patents and its benefits, inventions which cannot be patented as per Indian Patent Act 1970.

Textbooks

1. C.R.Kothari, Research Methodology- Methods & Techniques, Wishwa Prakashan, 2nd Ed., 2001, New Delhi.
2. Ranjit Kumar, Research Methodology- A Step by Step Guide for Beginners, Pearson, 2nd Ed., 2005, New Delhi.
3. B.K.Bose, Modern Power Electronics & AC Drives, Pearson Education Asia, 2003, Delhi.
4. Research Methodology & Statistical Techniques, Vision Publication, Pune, 2005, (www.visionpublications.in)
5. Intellectual Property India, the Patent Act 1970. (www.ieee.org/documents/opsmanual.pdf)

References

1. Intellectual Property India, Indian Patent Office, Comprehensive e-filing services for Patents, User Manual, 2012.
2. Manual of Patent Office Practice & Procedure, Office of Controller General of Patents, Designs & Trademarks, Mumbai,
3. Standard Format for Preparing the Synopsis of PhD/MS Thesis, Department of Electrical Engineering, IIT, Madras. (Available at: www.ee.iitm.ac.in/sites/default/files/eedownload/Synopsis_Format.pdf?)
4. IEEE Publication Services and Products Board Operations Manual, Section 8.2, 2013. (For Plagiarism)
5. B.K.Bose, "Global Warming: Energy, Environmental Pollution, and the Impact of Power Electronics," IEEE Magazine, Ind. Electronics, vol. 4, no. 1, 2010, pp. 6-17.
6. B.K.Bose, "How to get a paper accepted in transactions," IEEE Newsletter, Ind Electronics, vol. 53, no. 4, 2006. (also available at: http://eng.auburn.edu/users/aesmith/NSF_JournalPublication/articles/bose.pdf

PROCESSOR APPLICATIONS IN POWER SYSTEM

Course Code: EET554 **Total Credits: 04**

L: 4 hrs, P: 0 hrs. per week

Course Objectives:

1. To understand & review knowledge about architecture of 8085 along with some important PPI's.
2. To understand utility of 8051 microcontroller for better controlling of electrical circuits.
3. To get knowledge about measurement of electrical and non electrical quantities using processor and to understand Numerical Relays for over current and distance protection.

Course Outcome:

On completion of this course, the students will be able to,

CO1. Describe Architecture of 8085 Microprocessor along with timing Diagrams/Memory organization and interfacing of programmable peripheral devices with 8085

CO2. Effectively use instruction set and Write ALP for 8085 using subroutines, stacks, Interrupts, 8255 & 8253.

CO3. Describe Architecture of 8051, memory organization, ports, and timers, counters, interfacing with ADC/DAC.

CO4. Effectively use instruction set and Write ALP for 8051 Microcontroller using above utilities.

CO5. Describe functioning of Signal conditioning using specific circuits/ transducers and how to measure electrical or non-electrical quantities using processor

CO6. Program for operation of basic Numerical relays for over current and distance protection using ALP with 8085.

Syllabus:

Review of Microprocessors: Architecture and Programming of 8085 microprocessor, its interfacing with data converters (ADC), programmable peripheral interface 8255, programmable counter 8254, Serial I/O and data communication.

Microcontrollers: Difference between processor and controller, Architecture and programming of 8051 microcontroller, Special Function Registers, Internal RAM and ROM, Interfacing with external memory, programmable built in ports, on chip counters / timers, Serial Data Input/Output, Interrupts, assembly language Programming and applications, ADC, DAC interfacing with controller, Generation of PWM signals using Timer/counter.

Microprocessor based applications: Signal conditioning using Comparators, Clippers, Clampers, Precision Rectifier and Zero crossing Detector. Measurement of electrical quantities like AC voltage, Current, Frequency, and Phase angle, Power Factor and Energy. Measurement of non-electrical quantities like Strain, Temperature, Speed and Torque. Control of Firing circuits of Power Electronics systems. Flow charts-programming and schemes for basic Numerical Protective relays.

Text books:

1. Microprocessor Architecture, Programming and Applications with the 8085: Gaonkar Ramesh S., Penram International- latest Edition
2. The 8051Microprocessor Architecture, Programming & Applications: Ayala, Kenneth J. Penram International- latest Edition

Reference Books:

1. Op-Amps and Linear Integrated Circuits: Gaikwad Ramakant, Prentice Hall of India – latest Edition.
2. Fundamentals of Microprocessors and Microcomputers: Ram, B., Dhanpat Rai Publications- latest Edition.
3. Related IEEE papers/ NPTEL lectures.

PROCESSOR LAB.

Course Code: EEP554 **Total Credits: 01**

L: 0 hrs, P: 2 hrs. per week

Course Objectives:

1. To develop the logical and programming ability of student using processor.
2. To develop students to apply knowledge of processor for applications in electrical engineering.
3. To impart knowledge of interfacing tools for measurement of quantities and protection of power system using numerical relays.

Course outcome:

After completion of Processor Lab experiments, the student will be able to,

CO1. Work on microprocessor 8085 and micro-controller 8051 based professional kits.

CO2. Write Assembly Language program using 8085 and 8051 learn the programmable peripheral interface (PPI) using 8255 I/0 ports and 8253 counters.

CO3. Demonstrate the method of measurements of electrical and non electrical quantities for the protection of power system using numerical relays

Contents:

Practical based on,

- Assembly language programming for microprocessor 8085 & micro controller 8051 kits.
- Practical based on Interfacing of Programmable Peripheral Interface (PPI's) like 8255 & 8253.
- Practical based on Analog Circuit Simulation.
- Simulator for 8085 & 8051.
- Demonstration of protective relays based on processors.

Reference Books:

1. Microprocessor Architecture, Programming and Applications with the 8085: Gaonkar, Ramesh S., Penram International- latest Edition
2. The 8051 Microprocessor Architecture, Programming and Applications: Ayala, Kenneth J.,Penram International- latest Edition
3. Op-Amps and Linear Integrated Circuits: Gaikwad Ramakant, Prentice Hall of India – latest Edition.
4. Fundaments of Microprocessors and Microcomputers: Ram, B., Dhanpat Rai Publications- latest Edition.

SIMULATION LAB.

Course Code: EEP555 **Total Credits: 02**

L: 0 hrs, P: 4 hrs. per week

Course Objectives:

1. The course will prepare students to develop electrical systems for simulation using MATLAB, PSim & ETAP Softwares.
2. The course will prepare the students to develop programme in M-file in MATLAB.
3. The course will prepare the students to compare the simulation results with theoretical results.

Course Outcomes:

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

CO1. Simulate the power system/power electronics circuit using MATLAB / Simulink / Powersim / ETAP Softwares.

CO2. Analyze results of simulated circuit/system.

CO3. Write MATLAB programme in M-file for given power system based problems.

CO4. Analyze the results by theoretical calculation.

Contents:

The practicals will be based on electrical systems using following softwares.

1. MATLAB/ Simulink
2. ETAP Power Station,
3. Powersim,

They may include the following.

- Writing and testing programmes to study power system problems at different operating conditions.
- Designing model of single & three-phase converters, electrical machines/drives etc.
- Designing model of FACTS devices.

Reference Books:

1. Hadi Saadat, “Power System Stability”, TMH, New Delhi, 2010.
2. R. Krishnan, “Power Electronics”, Pearson Edition
3. S.G. Tarnekar, P.K. Kharbanda, S. B. Bodkhe, S. D. Naik, D.J. Dahigaonkar “A Textbook of Laboratory Courses in Electrical Engineering”, S. Chand & Co., New Delhi.
4. MATLAB Manual from MATHWORKS Inc.
5. Manual, ETAP Software
6. Manual, Powersim software

FACTS & HVDC TRANSMISSION

Course Code: EET556 **Total Credits: 04**

L: 4 hrs, P: 0 hrs. per week

Course Objectives:

1. To understand basics of HVAC and HVDC Systems.
2. To understand converter control modes, filtering harmonics and ripple.
3. To enable the students to acquire a comprehensive knowledge on various aspects of FACTS systems.
4. To develop ability to implement FACTS controller.

Course Outcomes:

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

CO1. Describe the types of topology of HVDC and HVAC system.

CO2. Describe converter operation in various modes.

CO3. Describe the application of filters to eliminates harmonics and design of smoothing reactor.

CO4. Apply knowledge of FACTS controller to AC transmission system.

CO5. Apply shunt, series and their combination for compensation.

CO6. Identify, formulate and solve network problems with FACTS controller.

Syllabus:

- Performance of HVAC, HVDC versus HVAC Transmission, Comparison of FACTS and HVDC, converter configuration for HVDC, VSI -HVDC and FACTS.
- Rectifier and Inverter operation, two valve, two/three valve, three/four valve operation, voltage current equations, control chart, Converter control, Control of HVDC converters and Systems.
- Individual phase control, Equidistant firing controls, Characteristics and non-characteristics harmonics filter design, smoothing reactor earthing, protection.
- Objectives of shunt Series compensation, operation of Shunt compensators, Series Compensator.
- Operation of Thyristor controlled Voltage and Phase Angle Regulator, Unified Power Flow, Controller, Interline power Plow Controller, Subsynchronous Resonance, NGH-SSR Damping, Thyristor Controlled Braking Resister.
- Power flow analysis with FACTS controller, combination HVDC and HVAC.
- Introduction to current technology in HVDC.

Text books:

1. Understanding of FACTS: Hingorani N. G., IEEE Press, (1996).
2. FACTS controller in Power Transmission & Distribution:1st Ed.: Padiyar K.R., New Age Int. (P) Ltd, (2007).
3. Direct Current Transmission, Vol.I: E. W. Kimbark, Wiley Interscience,(1971).
4. HVDC Power Transmission Systems: K. R. Padiyar, Wiley Eastern Ltd., (1990).

Reference Books:

1. Static Reactive Power Compensation: Miller T.J.E., John Wiley & Sons, New York, (1982).
2. Flexible AC Transmission System. (FACTs): Yong Hua Song, IEE (1999).
3. Power Transmission by Direct Current: Erich Uhlmann., B.S. Publications,(2004).
4. High Voltage Direct Transmission: J. Arrillaga, Peter Peregrinus Ltd. London, (1983).
5. Related IEEE papers/ NPTEL lectures.

M.Tech (PEPS) Semester - II

ADVANCED DRIVES

Course Code: EET557 **Total Credits: 04**

L: 4 hrs, P: 0 hrs. per week

Course Objectives:

1. To understand various mechanical couplings, gears, flywheels used in drives and equivalent torque and inertia reflected on driving system.
2. To understand phase controlled and chopper controlled DC drives.
3. To understand the speed control of 3-phase induction motor using voltage control, V/f control and vector control methods.

Course Outcomes:

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

CO1. : Determine the equivalent torque and inertia of a given drive with mechanical load.

CO2. : Determine the stability of electric drive.

CO3. : Select appropriate method for speed control of 3-ph. Induction motor depending on load requirement and describe its implementation.

CO4. : Understand the working of dc-dc converter fed drive and associated aspects.

CO5. : Understand the working of special motor drives like SRM drive, BLDC motor drive and PMSM drive.

Syllabus:

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

Phase controlled/chopper controlled DC motor drives: Design of controllers, converter selection & its characteristics, four quadrant operation, harmonics & associated problems.

AC Motor drives: VVVF induction motor drive, vector control and direct torque control drives.

Special Motor Drives: Brushless dc motor drives. Synchronous machines with PMs, control strategies, switched Reluctance Motor drives.

Design: Design of Power circuit and control circuits.

Text books:

1. Fundamentals of Electrical Drives: Dubey G.K. CRC Press, (2002).
2. Power Electronics and AC Drives: Bose B.K., Printice Hall, NJ, (1985).
3. Electric Machine Dynamics: Bridges I. & Nasar S.A., Macmilan Publishing Company, NY, (1986).
4. Electric Motor Drives, Modelling, Analysis and Control: Krishnan, R., Prentice Hall India, (2003).

Reference Books:

1. Control of Electrical Drives: Leonhard W., Narosa Publishing House, India (1984).
2. Analysis of Electrical Machinery: Krause P.C., McGraw Hill (1987).
3. Brushless Permanent Magnet & Reluctance Motor Drives: Teller T.J.E, Clarendom Press, (1989).
4. Related IEEE papers / NPTEL lectures

ADVANCED DRIVES LAB.

Course Code: EEP557 **Total Credits: 01**

L: 0 hrs, P: 2 hrs. per week

Course Objectives:

1. To understand the control circuit, pulse generating circuit and driver circuit for various converters e.g. AC to DC converter, DC to DC converter and DC to AC inverters.
2. To understand the characteristics of different power semiconductor switches & know their suitable applications.
3. To understand various topologies of converters & inverters for obtaining controlled AC or DC output.

Course Outcomes:

After completion of this course, students will be able to,

CO1. Select and use hardware tools and engineering systems for the purpose of study, measurement and testing of electrical drives.

CO2. Perform experiments on AC and DC drives and test their performance to verify the theoretical knowledge.

CO3. Simulate and study a complete drive system using engineering software and test its performance at different operating conditions.

CO4. Write reports to communicate effectively one's own observations, interpretation and conclusion after performing the experimentations.

Contents:

Experiments based on,

- Power semiconductor controlled AC & DC drive.
- Study of performance of these drives with different loads.
- Measurement of input power quality including p.f., harmonics & ripples generated by converter used in these drives.
- Study of controller circuits for these drives

Reference books:

1. Fundamentals of Electrical Drives: Dubey G.K. CRC Press, (2002).
2. Power Electronics and AC Drives: Bose B.K., Printice Hall, NJ, (1985).
3. Electric Machine Dynamics: Bridges I. & Nasar S.A., Macmilan Publishing Company, NY, (1986).
4. Electric Motor Drives, Modelling, Analysis and Control: Krishnan, R., Prentice Hall India, (2003).
5. Control of Electrical Drives: Leonhard W., Narosa Publishing House, India (1984).
7. Analysis of Electrical Machinery: Krause P.C., McGraw Hill (1987).
8. Brushless permanent Magnet & Reluctance Motor Drives: Teller T.J.E, Clarendom press, (1989).
9. Data sheets.

ADVANCED POWER SYSTEM PROTECTION

Course Code: EET558 **Total Credits: 04**

L: 4 hrs, P: 0 hrs. per week

Course Objectives:

The course will prepare students to understand,

1. The basic philosophy of power system protection.
2. Protection scheme for bus bars.
3. Protection scheme for low voltage and high voltage lines.
4. The principle, construction and application of numerical relays.

Course Outcomes:

After successful completion of this course students will be able to,

CO1. Understand the basic philosophy of power system protection

CO2. Design bus-bar protection scheme.

CO3. Apply over current protection scheme for distribution line and distance protection scheme for high voltage lines.

CO4. Understand the numerical relay and its programming aspects in time domain and frequency domain.

Syllabus:

Review of Power system Protection philosophy & Relays.

Instrument Transformers for Relaying.

Design of Protection Schemes for Transmission Lines

Design of Bus bar Protection Scheme.

Introduction to Numerical Relays.

Application of Numerical Relays for Power System Protection

Text books:

1. Fundamentals of Power system Protection: Dr. Y. G. Paithankar & Dr. S. R. Bhide.
2. Transmission Network Protection, Theory & Practice: Dr. Y. G. Paithankar
3. Digital Protection: L. P. Singh

Reference Books:

1. Protective Relays Application Guide: English Electric Company
2. Protective Relays: Theory & Practice: Warrington
3. Art & science of Protective Relaying: Mason

ENERGY AUDIT LAB.

Course Code: EEP 559 **Total Credits: 01**

L: 0 hrs, P: 2 hrs. per week

Course Objectives:

1. To understand the concept of energy audit and energy saving opportunities at office, home & industry.
2. To understand the power quality and harmonics in signal and their reduction method in drives.
3. To understand the concept of green building and star rating of appliances.

Course Outcomes :

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

CO1. Compare and implement the energy saving opportunities at home/ office/ industry.

CO2. Use the power quality analyzer for analysis the power quality.

CO3. Choose the efficient appliances by knowing the concept of star rating.

CO4. Plot a polar curve of lamps.

CO5. Calculate the intensity of light in the classroom, office, laboratory etc and comment on energy saving opportunities.

Contents:

The practicals are based on energy conservation,

- Energy saving opportunities.
- Exposure of different energy audit instruments like lux-meter, power quality analyzer etc.
- Use of MATLAB software for optimal load scheduling in thermal power plant.
- General awareness about the features of Energy Conservation Act

Reference Book:

1. Learning material from Bureau of Energy Efficiency, India. (http://beeindia.in/energy_managers_auditors)
2. MATLAB manual, Mathworks, Inc.
3. Manual of Power Quality Analyzer.

POWER QUALITY

Course Code: EET560-1 **Total Credits: 04**

L: 4 hrs, P: 0 hrs. per week

Course Objectives:

1. To introduce various power quality events.
2. To introduce indices used for the analysis of power quality events.
3. To introduce mitigation techniques for the improvement of power quality.
4. To introduce the application of switching controller for power quality improvement.

Course Outcomes:

On completion of this course, the students will be able to,

CO1. Identify the various power quality events like short and long duration variations, Waveform distortion, Unbalance, Transients, Power factor etc.

CO2. Analyze the power quality issues using the Power quality indices.

CO3. Suggest suitable mitigation strategies for some of the power quality issues.

CO4. Provide solution for the mitigation of power quality issues like waveform distortion, unbalance, and poor power factor.

Syllabus:

Origin of power quality variation & events, power quality indices, causes and effects of power quality disturbances, Characterization of power quality events & event classification. Power quality measuring instruments, Analysis of Power outages, unbalance, distortions, voltage sag, flickers & load balancing.

Reactive Power Compensation under non sinusoidal conditions, Effect of Harmonics on Transformers, Power quality problems created by drives and its impact on drives, Power factor improvement techniques, Passive Compensation, Harmonic Filters, DSTATCOM, DVR and UPQC: Structure & control of power converters, load compensation using DSTATCOM, Generation of reference currents, DVR/UPQC structures & control.

Text books:

1. Power quality enhancement using Custom Power Devices: Ghosh A. ,Ledwich G., Kluwer academic publication-Boston , (2002)
2. Power Quality: C.Sankaran,CRC Press,
3. Signal Processing of Power Quality Disturbances: Bollen Math H.J., GU Irene Y.H., Wilely Interscience Publication, IEEE Press, (2006).

Reference Books:

1. Understanding Power quality Problems Voltage Sags and Interruptions: Bollen Math H.J, IEEE Press, Standard Publishers Distributors, (2001).
2. Power Quality in Power Systems and Electrical Machines: Fuchs E.F., Masoum Mohammad A.S, Elsevier Academic Press, (2008).

DIGITAL SIGNAL PROCESSING

Course Code: EET 560-2 **Total Credits: 04**

L: 4 hrs, P: 0 hrs. per week

Course Objectives:

1. To understand the concept of discrete time signals and systems with their properties.
2. To understand the use of different transforms for discrete LTI systems.
3. To understand the representation and designing of the FIR and IIR filters.
4. To understand the different applications of DSP.

Course Outcomes:

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

CO1. Differentiate between different types of signals and systems.

CO2. Evaluate the discrete Fourier transform (DFT) and Fast Fourier transform (FFT) of a sequence

CO3. Compute the z-transform and inverse z transform of a sequence, & identify its region of convergence.

CO4. Represent and design the FIR and IIR filter

CO5. Describe the application of DSP in A/D and D/A conversion and speech recognition etc.

Syllabus:

Introduction: Signals, systems and signal processing, classification of signal concept of discrete time signals, sampling of analog signal and sampling theorem, anatomy of digital filter.

Discrete Time Signals & Systems: Classification, analysis of discrete time signals and systems, implementation of discrete time systems, correlation of discrete time signals, z transform and its application to the analysis of linear time invariant systems.

Discrete and Fast Fourier Transforms: Frequency domain sampling, proportion of DFT, efficient computation of DFT: FFT algorithms, Quantization effects in the computation of the DFT.

Digital Filters: Structures of FIR and IIR filters, design of FIR filters using windows; Optimum approximations of FIR filters using Parks- McClellan algorithm, Design of IIR filters from analog filters by bilinear transformations; impulse invariance method.

Applications of DSP: Applications of DSP to power system/power electronics/Instrumentation.

Text books :

1. Theory & application of digital signal processing: Rabiner-Gold, PHI, 1992.
2. Digital Signal processing: 3rd ed., Sanjit Mitra, McGraw-Hill Science / Engineering / Math ; 2005.

Reference Books:

1. Digital signal Processing: 3rd ed., Proakis-Manolakis, PHI, 2000.
2. Discrete time signal processing: 2nd ed., Oppenheim-Schetor, Prectice Hall, 1997.
3. Related IEEE papers/ NPTEL lectures.

ELECTRICAL POWER DISTRIBUTION & SMART GRID

Course Code: EET 561 **Total Credits: 04**

L: 4 hrs, P: 0 hrs. per week

Pre-requisites:

Before studying this course, student should know the following concepts.

1. Basics of electrical engineering & technical problems of power systems.
2. Basics of power generation, distribution and grid.
3. Methods/tools used for different measurements and controls.
4. Electrical switch gears and their functions.

Course Objectives:

1. Students will understand the various aspects of distribution system, energy forecasting & load forecasting techniques
2. Students will understand automation in electrical power distribution
3. Students will understand the working of sectionalizing switch and network reconfiguration.
4. Students will understand the use of SCADA in distribution system.
5. Students will understand the working of Smart Grid.

Course Outcomes:

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

CO1. Forecast the load and energy taking into consideration the available resources and smart techniques.

CO2. Identify the problems related with automation and SCADA and suggest suitable solution.

CO3. Understand the problems of restoration/ reconfiguration.

CO4. Describe real time schedule of operation of sectionalizing switches.

CO5. Distinguish between conventional grid and different types of smart grid

CO6. Discuss the use of smart technologies in smart grid.

Syllabus:

Load and Energy Forecasting: Distribution of power, Management, Power loads, Load forecasting, Power system loading, Technological forecasting. Need Based Energy Management (NBEM) – Objectives, Advantages, Distribution Management System (D.M.S.)

Distribution Automation: Definition, Restoration / Reconfiguration of distribution network Different methods and constraints. Interconnection of Distribution, Control & Communication Systems.

SCADA: Introduction, Block diagram, SCADA applied to distribution automation. Common Functions of SCADA, Advantages of Distribution Automation through SCADA.

Calculation of optimum number of switches, capacitors, Optimum Switching Device Placement in Radial. Distribution Systems. Sectionalizing Switches – Types, Benefits. Bellman's Optimality Principle, Remote Terminal Units.

Smart Grid: Introduction to Smart Grid, Definitions, Need, Functions, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self-Healing Grid, Present development & International policies in Smart Grid. Smart Grid Technologies: Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading (AMR), Outage Management System (OMS), Smart Sensors, Smart Substations, Smart storage like Battery, SMES, Micro grids and Distributed Energy Resources.

Text books :

1. Electric Power Distribution: 4th ed.: *Pabla A.S., Tata McGraw Hill., New Delhi (2000).*
2. Learning Material for Electrical Power Distribution: *Khedkar M.K., (2004).*
3. Smart Grid: Technology and Applications, Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Wiley.
4. Smart Grid: Fundamentals of Design and Analysis by James A. Momoh

References:

1. IEEE papers
2. NPTEL courses

VLSI DESIGN AUTOMATION

Course Code: ENT560 **Total Credits: 04**

L: 4 hrs, P: 0 hrs. per week

Course Objectives:

The objective of this course is to provide students with:

1. Fundamental Knowledge of VLSI CAD tool chain.
2. Techniques of Partitioning, floor-planning and routing
3. Basic Concepts of High level Synthesis

Course Outcomes:

Upon completion of this course, students should demonstrate the ability to:

CO1. Describe the VLSI design flow

CO2. Explain the algorithms for partitioning, floorplaning, placement and routing the digital designs.

CO3. Compare the various scheduling algorithms

Syllabus:

Introduction to VLSI CAD: VLSI design methodologies, use of VLSI CAD tools, Algorithmic Graph Theory and computational Complexity.

Partitioning: Introduction, Types of Partitioning, Classification of partitioning Algorithm, KL algorithm, FM algorithm etc.

Floorplanning: Introduction, Sliced and non-sliced planning, Polish expression.

Placement: Introduction, Classification of Placement Algorithms: Simulated annealing, partition based placement.

Routing: Fundamental Concepts such as Maze running, Line Searching, Steiner trees, Two phases of Routing: Global routing & detailed routing, Routing Algorithms.

High-level Synthesis: Hardware Models for High-level Synthesis, Internal Representation of the Input Algorithm, Allocation, Assignment and Scheduling, ASAP, Mobility based Scheduling, List scheduling, Force directed scheduling.

Basic Concepts of Static Timing Analysis

Text Books:

1. Algorithms for VLSI Design Automation: Sabih H. Gerez and John Wiley,(1998).
2. An Introduction to VLSI Physical Design: Majid Sarrafzadeh and C. K. Wong, McGraw Hill, (1996).
3. Algorithms for VLSI Physical Design Automation: Naveed Sherwani, Kluwer Academic Pub., (1999).

Reference Books:

1. Physical Design Essentials: An ASIC Design Implementation Perspective: Khosrow Golshan, Springer, (2007)
2. Handbook of Algorithms for Physical Design Automation: Charles J Alpert, Dinesh P Mehta, Sachin S. Sapatnekar, CRC Press, (2008).
3. Static Timing Analysis for Nanometer Designs: A Practical Approach: J. Bhasker and Rakesh Chadha, Springer, (2009).
4. Advanced ASIC Chip Synthesis: Using Synopsys Design Compiler, 2nd Edition: Himanshu Bhatnagar, Kluwer Academic, (2001).

OPTIMIZATION TECHNIQUES IN ARTIFICIAL INTELLIGENCE

Course Code: CST575-1 **Total Credits: 04**

L: 4 hrs, P: 0 hrs. per week

Course Outcomes:

On successful completion of the course, students will be able to:

CO1. Explain how biological systems exploit natural processes.

CO2. Analyze how complex and functional high-level phenomena can emerge from low-level interactions.

CO3. Understand how large numbers of agents can self-organize and adapt.

CO4. Design and implement simple bio-inspired algorithms.

Syllabus:

INTRODUCTION- What is Life? Life and Information, The Logical Mechanisms of Life, What is Computation? Universal Computation and Computability, Computational Beauty of Nature (fractals, L-systems, Chaos) Bio-inspired computing, Natural computing, Biology through lens of computer science.

COMPLEX SYSTEMS AND FUZZY SYSTEMS - Complex Systems and Artificial Life, Complex Networks - Self-Organization and Emergent Complex Behavior, Cellular Automata, Boolean Networks, Development and Morphogenesis, Open-ended evolution, Introduction to Fuzzy Set Theory, Uncertainty and Fuzzy, Hedges and Alpha Cuts, Fuzzification Models, Methods of Defuzzification

NATURAL COMPUTATION AND NEURAL NETWORKS -Biological Neural Networks, Artificial Neural Nets and Learning, pattern classification & linear separability, single and multilayer perceptrons, backpropagation, associative memory, Hebbian learning, Hopfield networks, Stochastic Networks, Unsupervised learning.

EVOLUTIONARY SYSTEMS AND ALGORITHMS -Evolutionary Programming: biological adaptation &evolution , Autonomous Agents and Self-Organization: termites, ants, nest builiding,flocks, herds, and schools. Geneticalgorithms: Schema theorem, Reproduction, Crossover, Mutation operators.

COMPETITION, COOPERATION AND SWARM INTELLIGENCE- Collective Behavior and Swarm Intelligence, Social Insects , Stigmergy and Swarm Intelligence; Competition and Cooperation , zero- and nonzero, sum games, iterated prisoner's dilemma, stable strategies, ecological & spatial models, Communication and Multi-Agent simulation – Immuno computing.

Text and Reference Books:

1. Leandro Nunes De Castro, Fernando Jose Von Zuben, “Recent Developments in Biologically Inspired Computing”, Idea Group Publishing, 2005.
2. Leandro Nunes De Castro , “Fundamentals of Natural Computing: Basic concepts, Algorithms and Applications”, Chapman & Hall/ CRC Computer & Information Science Series, 2006.
3. Dario Floreano, Claudio Mattiussi, “Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies”, MIT Press, 2008.
4. George J. Klir & Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory & Applications, Prentice Hall, 2005

Websites and External Links:

1. http://informatics.indiana.edu/rocha/i-bic/
2. http://web.eecs.utk.edu/ ~ mclennan/Classes/420/
3. http://www.cs.stir.ac.uk/courses/31YB/

SOCIAL NETWORK ANALYSIS

Course Code: CST575-2 **Total Credits: 04**
L: 4 hrs, P: 0 hrs. per week

Course Outcomes:

On successful completion of the course, students will be able to:

CO1. Understand the fundamental principles of social network analysis and applications.
CO2. Apply network-based reasoning to elicit social policy recommendations.
CO3. Understand the measures of network composition and structures in social phenomenon.
CO4. Understand the opportunities and challenges due to pervasive social network data on the internet

Syllabus:

Social network data:
Introduction &What's different about social network data? Nodes, boundaries, Modality Relations , Sampling ties, Multiple, Scales. Why formal methods? Using graphs to represent social relations. Using matrices to represent social relations. Connection and distance, Networks and actors, exchange, Connection, demographics, Density, Reachability, Connectivity, Distance ,Walks etc., diameter, Flow.

Network centrality:
Density, Reciprocity, Transitivity, Clustering, Krackhardt's Graph Theoretical Dimensions of Hierarchy. Ego networks, Centrality and power, Degree centrality Degree: Freeman's approach, Closeness, Betweenness Centrality

Cliques and Sub-groups:
Groups and sub-structures, Bottom-up approaches ,Top-down approaches, Defining equivalence or similarity ,Structural equivalence, Automorphic, Regular equivalence, Measures of similarity and structural equivalence.

Measuring similarity/dissimilarity:
Pearson correlations covariance's and cross-products, distances, Binary , Matches: Exact , Jaccard , Hamming, Visualizing similarity and distance ,Describing structural equivalence sets :Clustering similarities or distances profiles, CONCOR 37

Automorphic Equivalence:
Defining automorphic equivalence, Uses of the concept, Finding equivalence Sets, All permutations (i.e. brute force), Optimization by tabu search, Equivalence of distances: Maxsim

Small world network models, optimization, strategic network formation and search Concepts:
Small worlds, geographic networks, decentralized search, Contagion, opinion formation, coordination and cooperation, SNA and online social networks

Reference Books:

1. Hanneman, Robert A. and Mark Riddle. 2005. Introduction to social network methods. Riverside, CA: University of California.
2. Stanley Wasserman and Katherine Faust; Social Network Analysis - Methods & Applications; Cambridge Univ. press; 1998.
3. John Scott: Social Network Analysis - A Handbook; Second Edition ; SAGE Publication; 2000.
4. CharuAgrawal; Social Network Data Analytics ; Springer; 2011.
5. WouterNooy, Andrei Movar and Vladimir Batagelj; Exploratory Social Network Analysis with Pajek; Cambridge Univ. press; 2005.

ENERGY MANAGEMENT SYSTEM

Course Code: EET 599 **Total Credits: 03**
L: 3 hrs, P: 0 hrs. per week

Pre-requisites :

Before studying this course, student should know the following.
Basics of electrical engineering of UG level.

Course Objectives:

1. To understand the concept of optimal load scheduling and unit commitment for thermal & hydrothermal systems.
2. To understand the concept of connection of renewable energy sources to a grid.
3. To understand the concept of energy audit.
4. To understand the concept of load flow analysis.

Course Outcomes:

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

CO1. Differentiate between the optimal load scheduling and unit commitment problem.
CO2. Calculate the optimal load scheduling for hydrothermal plant.
CO3. Identify the type, methodology and tools of energy audit for a given load/premises.
CO4. Apply the load flow studies to a given problem.
CO5. Describe the integration of renewable energy sources with grid.

Syllabus:

Review of Load flow analysis and short circuit analysis.
Basic structure of Energy management system, Optimal operation of generator, Input output curve, Heat rate curve, emission dispatch, optimal unit commitment, dynamic programming, different constraints, Optimum generation allocation to thermal units with and without transmission losses, representation and derivation of transmission loss formula by B coefficient and power flow equation,
Optimal power flow: problem, objective, constraints (equality and inequality constraint), solution methodologies.
Hydro-thermal co-ordination: Mathematical formulation and its solution technique.
Different methodologies for Reactive power optimization, overview of Mathematical programming techniques, Artificial intelligence techniques, Evolutionary computation techniques.
Basic components of electrical energy systems such as rotating electric machine, transformers and transmission lines, Methods of energy conservation with an emphasis on fundamentals and rigor, Non conventional energy conversion systems – their energy conversion systems.
Energy audit: Industrial energy procedures and documentation techniques, Instrumentation for energy audit.

Text Books:

1. Power System Engineering: *Nagrath and Kothari, Tata McGraw-Hill, (2003).*
2. Power System Operation and Control: *PSR Murthy, Tata McGraw-Hill, New Delhi, (1984).*

Reference Books:

1. Power Generation Operation and Control: *A.J. Wood and B.F. Wollenberg, John Wiley & Sons INC, (1984).*
2. Economic Operation of Power System: *L.K. Kirchmayer, Economic Operation of Power System, John Wiley, New York, (1958).*
3. www.beeindia.in/: *Bureau of Energy Efficiency.*

M.Tech (PEPS) Semester - III

MICROCONTROLLER APPLICATIONS IN POWER CONTROLLERS

Course Code: EET651-1 **Total Credits: 04**

L: 4 hrs, P: 0 hrs. per week

Course Objectives:

1. To introduce Microcontroller as a tool for the development of applications in Power converter.
2. To introduce Microcontroller programming using assembly/C language.
3. To introduce the on-chip peripherals useful in development of power converter control system.
4. To introduce applications of Microcontroller in AC/DC drives, Power supplies and Power converters.

Course Outcomes:

On completion of this course, the students will be able to,

CO1. Understand the architecture and use of various on-chip peripherals of microcontroller.

CO2. Develop programs using assembly language/C for microcontroller.

CO3. Develop algorithms for various control system blocks for power converters.

CO4. Discuss the use of Microcontroller in power converters using block diagrams.

Syllabus:

Evolution of micro-controller, comparison between micro processor and micro controllers. Micro-controller development systems, Microcontrollers - architecture - hardware description.

Introduction to GPIO, Memory, Interrupt structure, Timer, ADC , UART, I2C bus operation and Programming.

Typical application in the control of power electronic converters for Power supplies, Electric motor drives and Power system.

Text books:

1. Microprocessor and Interfacing –Programming and Hardware: Douglas V. Hall, TMH, 2003
2. Design with microcontrollers: John. B. Peatman, McGraw Hill International Ltd., 1997
3. Modern Power Electronics and AC Drives: B.K.Bose, Prentice Hall; First edition.
4. AVR Microcontroller and Embedded Systems: Using Assembly and C: by Muhammad Ali Mazidi, Sarmad Naimi and Sepehr Naimi. Pearson Custom Electronics Technology.
5. www.microchip.com

References:

Data sheets of hardware components

ELECTRIC VEHICLES

Course Code: EET651-2 **Total Credits: 04**

L: 4 hrs, P: 0 hrs. per week

Course Objectives:

1. To introduce the electrical systems of conventional vehicle.
2. To introduce the electrical system architecture in hybrid and electric vehicles..
3. To introduce application of fuel cells, advanced electric motors and converters in electric vehicles.

Course Outcomes:

On completion of this course, the students will be able to,

CO1. Compare the architecture of electrical systems in conventional, hybrid and electric vehicles.

CO2. Understand the various aspects of fuel cell and its application in electric vehicles.

CO3. Understand the working of advanced electric motors and their application in electric vehicles.

CO4. Understand the use of power electronic converters for control of several loads in electric vehicle.

CO5. Understand the stability aspects and dynamics in a dc vehicular distribution system.

Syllabus:

Automotive Power System: Conventional electrical system architecture, electrical loads in vehicle, starter, alternator and integrated starter/alternator, automobile steering system, semiconductors for automotive applications, automotive communication networks.

Electric & Hybrid Vehicles: Principles and architecture of hybrid electric drive trains, electric distribution system architecture, more electric hybrid vehicles, hybrid control strategies, hybridization effects, heavy duty vehicles.

Fuel Cell Based Vehicles: Structure, operation and properties of fuel cell, fuel cell properties for vehicles, light duty and heavy duty vehicles, current status and future trends in fuel cell vehicles.

Advanced Motor Drives for Vehicular Applications: Brushless dc motor drives, switched reluctance motor drives.

Multi-converter Vehicular Dynamics & Control: Multi-converter vehicular power electronic system, constant power loads and their characteristics, concept of negative impedance stability, stability of PWM DC/DC converters driving several loads, stability condition in a dc vehicular distribution system.

Textbooks:

1. Vehicular Electric Power Systems-Land, Sea, Air and Space Vehicles by Ali Emadi, Mehrdad Ehsani, John M. Miller, Marcel Dekker Inc. Special Indian Edn, (Yes Dee Publishing Pvt. Ltd, Chennai) 2010.
2. AC Motor Control & Electric Vehicle Applications by Kwang Hee Nam, CRC Press, Special Indian Edn, (Yes Dee Publishing Pvt. Ltd, Chennai) 2013.
3. Electric Vehicle Battery Systems by Sandeep Dhameja, Elsevier India Pvt. Ltd, 2013.

References:

1. Recent IEEE papers
2. NPTEL courses

RENEWABLE POWER GENERATION SOURCES

Course Code: EET651-3 **Total Credits: 04**

L: 4 hrs, P: 0 hrs. per week

Course Objectives :

1. Students will understand the basic characteristics of photovoltaic cells and their use for battery charging.
2. Students will understand the modeling, performance and integration of wind driven induction generators with grid.
3. Students will understand various aspects of wind-diesel systems, permanent magnet alternators and integrated wind solar systems.
4. Students will understand the layout and operation of other renewable energy sources like micro-hydel systems, geothermal systems and tidal systems.

Course Outcomes (CO):

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

CO1. Draw and analyze the basic characteristics of solar cells

CO2. Correlate characteristic features of windmills with their performance

CO3. Characterize the power generation by wind driven induction generator with respect to transmission and distribution system

CO4. Model the steady-state equivalent circuit of wind-diesel system

CO5. Determine the generation efficiency of parallel operated system

Syllabus:

Basic characteristics of sunlight-solar energy resource-photovoltaic cell, equivalent circuit- photo voltaic for battery charging.

Wind source-wind statistics-energy in the wind-aerodynamics-rotor, types-forces developed by blades-power performance.

Wind driven induction generators, power circle diagram, steady state performance, modeling, integration issues, impact on central generation- transmission and distribution systems, wind farm electrical design.

Wind-diesel systems-fuel savings, permanent magnet alternators, modeling-steady state equivalent circuit, self excited induction generators, integrated wind solar systems.

Micro-hydel electric system-power potential –scheme layout-generation efficiency and turbine part flow-isolated and parallel operation of generators-geothermal-tidal and OTEC system.

Text books:

1. Wind Energy Technology, John F. Walker & Jenkins. N., John Wiley and Sons, Chichester, U.K. (1997).
2. Physics, Technology and use of Photovoltaics: Van Overstraeton and Mertens R.P., Adam Hilger, Bristol, (1996).
3. Wind Energy Conversion System: Freries LL, Prentice Hall, U.K. (1990).

References:

1. Related IEEE papers/ NPTEL lectures

POWER SYSTEM DYNAMICS & CONTROL

Course Code: EET 652-1 **Total Credits: 04**

L: 4 hrs, P: 0 hrs. per week

Course Objectives:

1. To give a broad knowledge of dynamic system and the links between power system steady state analysis and transient analysis.
2. To study voltage and frequency stability analysis of transient and dynamic systems.
3. To understand power system control; Voltage control; power system transient stability control; power system Dynamic stability control.
4. To understand and familiarize with different type of numerical integration algorithm used for transient stability analysis of power system.
5. To understand how system respond to various inputs.

Course Outcomes:

After completion of this course, students will be able to,

CO1. Analyze the principle of dynamical system and control theory to model power system.

CO2. Apply control and stability technique to power system.

CO3. Use mathematical tools and models to formulate and solve stability problems.

CO4. Analyze dynamic systems in time domain.

CO5. Explain how dynamic systems are controlled

Syllabus:

Basic concept of stability, Dynamics of synchronous machines, power angle equation, Classification of stability, Power system control, Design and operating criteria for stability, Midterm and long term stability

Rotor angle stability, classical method of rotor angle stability, equal area criteria for SMIB system, Two machine system, Numerical solution of swing equation, Multimachine stability, factor affecting transient stability.

Voltage stability & Voltage Collapse, Reactive power and voltage control, Voltage stability analysis, different criteria for voltage stability, P-V and Q-V curves, countermeasures for voltage collapse.

Frequency stability, Load frequency control (Single area and two areas) steady sate and dynamic, automatic voltage control.

Methods of improving stability, transient stability enhancement, small signal stability enhancement, power system stabilizer, AVR.

Sub synchronous resonance and countermeasures, Different filtering schemes.

Text Books:

1. Power System stability and Control by P. Kundur.
2. Power System Dynamics and Control by K.R. Padiyar.
3. Power System control and stability by P. M. Anderson & A. A.Fouad.

Reference Books:

1. Power System Dynamics stability and control by Jan Machowski, Janusz W.Bialek, J. R.Bumby
2. Related IEEE papers / NPTEL lectures

ADVANCED CONTROL THEORY

Course Code: EET 652-2 **Total Credits: 04**

L: 4 hrs, P: 0 hrs. per week

Course Objectives:

1. To understand different optimization techniques.
2. To understand the digital controllers for stability analysis.
3. To understand the different feedback control designs.

Course Outcomes:

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

CO1. Apply different stability analysis techniques to analog and digital systems.

CO2. Design the state feedback controllers.

CO3. Optimize the system to achieve desired performance.

CO4. Analyze the discrete time control system.

Syllabus:

Stability Analysis: Stability of Equilibrium State in the Sense of Liapunov; Liapunov's Stability Test,Second Method of Liapunov; Liapunov Function Based on Aizerman's Method ,Variable Gradient Method.

State Feedback Control Design: State Feedback Control-Pole Placement Design, State Feedback with Integral Control, Observer-based State Feedback Control, Digital Control Design using State Feedback.

Optimal Control System: Calculus of Variation , The Lagrangian and Hamilton Functions, Pontryagin's Principle, Dynamic Programming for Optimal Control.

Digital Control System: Representation of SDCS. Sample & Hold Circuit. Z – Transform. Inverse Z- Transform & solution of difference equation. Z & S domain relationship.Stability by bilinear transformation & Jury's test. Comparison of time response of continuous and digital control system ,Effect of sampling period on transient response characteristic Discritization of continuous time state equation. Solution of Discrete time state equations. Controllability & Observability of discrete time systems.

Text Books:

1. Modern Control Engineering, Fourth Edition, Prentice Hall, 2001- Katsuhiko Ogata
2. Automatic Control Systems, High Education Press, 2003- B. C. Kuo
3. Control Systems Engineering, Fifth Edition, New Age International Publishers, 2007- L. J. Nagrath & M. Gopal

Reference Books:

1. Advanced Control System, First Edition, M.Rihan
2. Control Systems: Principle and Design ,Fourth Edition, M.Gopal

CIRCUIT SIMULATION & HARDWARE IMPLEMENTATION LAB.

Course Code: EEP653 **Total Credits: 02**

L: 0 hrs, P: 4 hrs. per week

Course Objectives:

1. The course will prepare students to develop circuit for simulation.
2. The course will prepare students to develop circuit for prototype.
3. The course will prepare students to analyze results of simulation and hardware.

Course Outcomes:

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

CO1. Simulate the circuit using MATLAB

CO2. Simulate the circuit in PSim

CO3. Analyze results of simulated circuit.

CO4. Fabricate modules/ prototype in group and individually.

Contents:

Practicals based on:

- Circuit simulation for power electronic converter and its controller.
- Circuit simulation for power system models.
- Fabrication of hardware models.

References:

1. Manuals of softwares and hardware tools.
2. Data sheets of hardware components.

PROJECT PHASE - 1

Course Code: EEP654 **Total Credits: 06**

Course Outcomes:

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

CO1. Communicate effectively by using power point presentation

CO2. Take initiative and conduct self-study with commitment to improve own knowledge & competence.

CO3. Conduct literature survey effectively

Assessment by:

Project Supervisor and Project Review Committee Members

M.Tech (PEPS) Semester - IV

PROJECT PHASE – 2

Course Code: EEP655 **Total Credits: 12**

Course Outcomes:

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

CO1. Conduct literature survey effectively

CO2. Analyze critically

CO3. Learn and apply simulation tools/ hardware tools/IE rules etc for the purpose of study/ simulation/ design/ fabrication to execute the project

CO4. Take initiative and conduct self-study with commitment to improve own knowledge and competence.

CO5. Analyze the outcome of one's own efforts, learn from mistakes and take corrective measures without depending on external feedback.

CO6. Communicate effectively by using power point presentation.

CO7. Demonstrate the knowledge of project management principles with due consideration of economical and financial factors.

CO8. Understand professional and ethical responsibility

CO9. Perform multidisciplinary research

CO10. Write effective project report/ dissertation.

Evaluation:

Dissertation / Viva-Voce on project work