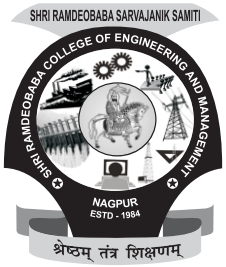

SHRI RAMDEOBABA COLLEGE OF ENGINEERING AND MANAGEMENT, NAGPUR – 440013

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

PROGRAMME SCHEME & SYLLABI
2021 – 2022

M. Tech. (Power Electronics and Power System)

Published By

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ISO 9001 : 2015 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 intake of 60 students. The National Board of Accreditation has accredited the department five times in succession in the year 2001, 2006, 2013, 2017 & 2020. Presently, the Electrical Engineering Department has post graduate program (M. Tech. in Power Electronics and Power Systems) with sanctioned intake of 18, started from 2011. Department is a Recognized Research Centre, approved by RTM Nagpur University for Doctoral program. Department has twelve well-equipped laboratories.

Department has two Professors, eight Associate Professors and eleven Assistant Professors on the roll. Department 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. Department organizes Seminars, Guest lectures, Training programs and 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 the industry, the department organizes Technical Workshop cum Exhibition named "EMPOWER". This mega event is organized in the department for five times in year 2012, 2013, 2014, 2017 and 2018. Reputed companies namely ABB, Artic Infra Tech, Grandstream, Grundfos, Hager, Hioki, KEI Cables, L&T, Powerica, Wipro, Bergen, Biosys, HP, Rockwell Automation, Schneider, Siemens, Texas Instruments, Finolex, Highrise Transformers, TDK, Waree, Gentech, Synergy, VSP aqua mist etc. participated in the exhibition with the wide range of products to display. Around 300 students from more than 23 Engineering colleges attended these workshops every year.

On academic front, the department results are consistently good. The department 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, internships and projects.

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 scholarly environment for students to achieve excellence in case electrical and multi disciplinary fields by synergetic efforts of all stake holders of the Electrical Engineering Department and inculcate the ethical and social values.

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 shall have,

PO 1. An ability to carry out independent research / investigation and development work to solve practical problems.

PO 2. An ability to write and present an effective technical report / document.

PO 3. An ability to demonstrate a degree of mastery over the area in Power Electronics and Power system.

PSO 1. An ability to understand, analyse and design the electrical drives, power converters and control circuits for specific application.

PSO 2. An ability to develop and utilize modern tools for modelling, analysing and solving various engineering problems related to Power system.

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.	Category	Course Name	L	P	Credits	Maximum marks			ESE Duration (Hrs)	Category
						Continuous Assessment	End Sem Exam	Total		
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.	EET564	Programming Applications in Power Electronics and Power System	3	0	3	40	60	100	3 Hrs.	PC
4.	EET553	Research Methodology	3	0	3	40	60	100	3 Hrs.	FC
5.	EET566	Microcontroller : Programming and System Design	4	0	4	40	60	100		PC
6.	EEP566	Microcontroller : Programming Lab.	0	2	1	25	25	50	3 Hrs.	PC
7.	EEP567	Simulation Tools and Programming Lab	0	4	2	25	25	50		PC
8.	EET556	FACTS & HVDC Transmission	4	0	4	40	60	100	3 Hrs.	PC
9.	HUP506	Professional Communication and Employability Skills	0	2	1	50	0	50		
		TOTAL	**18**	**10**	**23**			**700**		

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

Sr. No.	Category	Course Name	L	P	Credits	Maximum marks			ESE Duration (Hrs)	Category
						Continuous Assessment	End Sem Exam	Total		
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	3 Hrs.	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
EET560-3	Hydrogen Energy and Fuel Cell
EET560-4	IoT and It's Applications in Energy Sector

Group Elective	
EET563	Micro controller Applications in power controllers and Power System
ENT560	VLSI Design Automation
CST561-1	Optimization Techniques in Artificial Intelligence
CST561-2	Social Network Analysis

Open Elective	
EET599	Energy Management System

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

Sr. No.	Category	Course Name	L	P	Credits	Maximum marks			Exam Duration	Category
						Continuous Assessment	End Sem Exam	Total		
1.	EET651-X	Program Elective II	4	0	4	40	60	100	3 Hours	PE
2.	EET652-X	Program Elective III	4	0	4	40	60	100	3 Hours	PE
3.	EEP653	Circuit Simulation and Hardware Implementation Lab.	0	4	2	25	25	50	–	PC
4.	EEP654	Project Phase - I	-	3	6	100	100	200		Project
		TOTAL	**8**	**7**	**16**			**450**		

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

Program Elective - II	
EET651-2	Electric Vehicles
EET651-3	Renewable Power Generation Sources
EET651-4	Electrical Power Distribution and Smart Grid
EET651-5	Industry Offered Elective

Program Elective - III	
EET652-1	Power System Dynamics & Control
EET652-4	Digital and Optimal Control System
EET652-3	Industry offered elective
EET652-5	Power System Modeling and Analysis

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

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

Total credits = 72; Total Marks = 2150

Syllabus of Semester I

M. Tech (Power Electronics & Power System)

Course Code : EET551 **Course : Advanced Power Electronics**

L: 4 hrs, P: 0 hrs. per week **Total Credits: 04**

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 & 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.

Syllabus of Semester I

M. Tech (Power Electronics & Power System)

Course Code : EEP551 **Course : Advanced Power Electronics Lab.**

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

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).

Syllabus of Semester I
M. Tech (Power Electronics & Power System)

Course Code : EET564 **Course : Programming Applications to Power Electronics and Power System**

L: 3 Hrs, T: 0 Hrs. P: 0 Hrs. per week Total Credits : 03

Course Objectives

The objective of the course is to prepare the students:

1. Acquire problem solving skills
2. Applications related to Electrical Engineering using Python language.

Course outcomes

At the end of this course students will be able to

CO1: Interpret the python syntax and semantics of control flow statements

CO2: Apply functions and modules in Python to solve a problem

CO3: Apply 3rd party packages for developing solutions for real time problems.

CO4: Implement the application in real world.

Python Fundamentals: History-Origins of python, Features of Python- why choose python,what can I do with python, Installing Python installation on windows. Variables, Expressions & Statements, Conditional Execution, Iterations, Functions, Modules, Lists, Dictionaries, Tuples, Strings, Files and Exceptions, GUI Programming.

Electrical applications using Python: Circuit analysis, transfer function representation, frequency response analysis, Introduction to sampling, DFT, filter design, load flow analysis using PyPSA module, abc to dq transformation, Simulation of various energy sources, Simulation of power converters.

Text Books

1. Fundamentals of Python: First Programs Author: Kenneth Lambert Publisher: Course Technology, Cengage Learning, 2012 ISBN-13: 978-1-111-82270-5
2. Core Python Programming: Dr.Nageshwar Rao: Dreamtech Press 2nd Edition
3. Python Programming: Michael Urban and Joel Murach, Shroff/Murach, 2016
4. Digital Signal Processing- A computer based approach: S. K. Mitra, McGraw Hill, 2011.

Reference Books

1. Programming Python: Mark Lutz, , O` Reilly, 4th Edition, 2010
2. Core Python Programming: Wesley J. Chun, Second Edition, Pearson

Syllabus of Semester I

M. Tech (Power Electronics & Power System)

Course Code : EET553 **Course : Research Methodology**

L: 3 hrs, P: 0 hrs. per week **Total Credits : 03**

Course Objectives

1. To introduce the concept of engineering research including selection of problem, literature review, hypothesis, research methodology, professional ethics and criteria for good research.
2. To introduce various aspects of technical paper writing, report writing and 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. Understand research problem formulation and developing of research proposal.

CO2. Conduct literature survey and analyze research related information.

CO3. Recognize the importance of AI methods, and simulation studies in engineering research

CO4. Write a technical paper and communicate the findings effectively.

CO5. Understand research ethics and journal ranking.

CO6. Understand various aspects of intellectual property rights.

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

Meaning of research problem, selection of research problem, research process, setting objectives of research, developing a research proposal, format of research synopsis.

Literature review

Significance and procedure of literature review, types of literature, current areas of research in electrical engineering, standard national and international journals on electrical engineering, environmental and societal aspects in engineering research.

Hypothesis

Construction, functions, types of hypothesis, errors in testing of hypothesis.

Technical Paper Writing, Report Writing and Power Point Presentation

Necessities of good technical paper, paper format, approach towards writing different components of technical paper, do's and don'ts in paper writing, writing references, technical report writing, effective power point presentation skills. Data Presentation Skills: Histogram, bar charts, pie charts, 2D & 3D plots, interpolation, extrapolation, curve fitting, FFT.

Programme Scheme & Syllabi M. Tech. (Power Electronics and Power System)

Simulation Tools

Basics of MATLAB, Simulink, PSim and their application in electrical engineering, sample examples on simulation study of electrical systems.

Basics of AI Methods

Basics of expert system, basics of fuzzy logic, basics of ANN, sample examples using MATLAB software.

Research Ethics & Journal Ranking

Plagiarism, IEEE levels of plagiarism, methods to avoid plagiarism, journal impact factor, eigenfactor score, h- index, citation, indexing.

Intellectual Property Rights

Patents, design, trade mark and copyright, benefits of IPR, inventions which cannot be patented in India, procedure for application and grant of patents, Patent Cooperation Treaty (PCT).

Books/References

1. Ranjit Kumar, "Research Methodology: A step by step guide for beginners," Pearson, 2nd Ed. 2005, New Delhi.

2. C. R. Kothari, "Research Methodology: Methods & Techniques," Wishwa Prakashan, 2nd Ed. 2001, New Delhi.

3. B. K. Bose, "Modern Power Electronics & AC Drives," Pearson Ed. Asia, 2003, Delhi.

4. 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.

5. B. K. Bose, "How to get paper accepted in transactions," IEEE Newsletter, Ind. Electronics, Vol. 53, No. 4, 2006.

6. Standard Format for Preparing the Synopsis of PhD/MS Thesis, Dept. of Electrical Engg., IIT Madras (Available at: www.ee.iitm.ac.in/sites/default/files/eedownload/synopsis_Format.pdf)

7. IEEE Publication Services and Products Board Operations Manual, Section 8.2, 2013.

8. Intellectual Property India: The Patent Act 1970.

9. Intellectual Property India, Indian Patent Office, Comprehensive e-filing services for Patents, User Manual 2012.

10. Manual of Patent Office Practice & Procedure, Office of Controller General of Patents, Designs & Trademarks, Mumbai.

11. Related NPTEL course

Additional References

12. T. Ramappa, "Intellectual Property Rights under WTO," S. Chand & Co., New Delhi, 2008*.

13. Stuart Melville, Wayne Goddard, "Research Methodology: An introduction for science & engineering students" Juta & Company, 1996*

Syllabus of Semester I

M. Tech (Power Electronics & Power System)

Course Code : EET566 **Course : Microcontroller Programming and System Design**

L: 4 Hrs, T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 04**

Course Objectives

The objective of this course is to make the students familiar with microcontroller, its programming and microcontroller based system designing.

Course Outcomes

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

CO1 : Understand the architecture and organisation of microcontroller.

CO2 : Use assembly language and Embedded C for microcontroller programming.

CO3 : Understand the use of various peripherals for system designing.

CO4 : Design simple applications using microcontroller.

Syllabus

Introduction: Review of microcontrollers, architecture, memory organisation, CPU details, Interrupt structure, addressing modes, peripheral Modules. Introduction to Instruction set.

Microcontroller Programming : Introduction, C Compiler, Integrated development environment, Introduction to GPIO, Timer, ADC, DAC, Memories; Serial Communication: Operation and Programming, Peripheral programming, Interrupt programming using C

Microcontroller based system design: Introduction to system design approach, Hardware development, firmware development. Microcontroller based application development.

Books

1. The AVR microcontroller and Embedded systems using assembly and C, Muhammad Ali Mazdi, Sarmad Naimi and Sepher Naimi 2011, Prentice Hall.
2. Embedded C Programming and the Atmel AVR, Second Edition Richard Barnett, Larry O'Cull and Sarah Cox, Delmar, Cengage Learning
3. Go Embedded, Second Edition Asang Dani, Yeshwant Kanetkar, B.P.B. Publication.

Ref Books/Resources

1. Programming And Customizing The AVR Microcontroller by Dhananjay Gadre, Tata McGraw-Hill Education
2. Product Datasheets

Syllabus of Semester I
M. Tech (Power Electronics & Power System)

Course Code : EEP566 **Course : Microcontroller Programming Lab**

L: 2 Hrs, T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 01**

Course Objective

The objectives of this laboratory course are to prepare students for Microcontroller programming, introduce the open source/proprietary development environment and make them acquainted with microcontroller development board.

Course Outcomes

At the completion of this course, students will be able to:

CO1: Use open source or proprietary development environment and microcontroller development board for Microcontroller programming.

CO2 : Implement control algorithm using suitable programming language.

CO3 : Set up the circuit on microcontroller development board for testing of program.

CO4 : Debug the program to make it working.

CO5 : Design a small application based on microcontroller

Ref Books/Resources

1. Product Datasheets
2. Laboratory manual
3. Open source development tool guide

Syllabus of Semester I

M. Tech (Power Electronics & Power System)

Course Code : EEP567 **Course : Stimulation Tools and Programming Lab**

L: 2 Hrs, T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 01**

Course Objective

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 electrical applications programmingusing
3. Python.
4. The course will prepare the students to compare the simulation results with theoretical results.

Course Outcomes

At the completion of this course, students will be able to:

CO1 : Simulate the power system/power electronics circuit using MATLAB / Simulink / P-Sim / ETAP Software / Open Source Software.

CO2 : Programme the power system/power electronics circuit using Python..

CO3 : Analyze results of simulated circuit/system.

References

1. Hadi Saadat, "Power System Stability", TMH, New Delhi, 2010.
2. MATLAB Manual from MATHWORKS Inc
3. Manual, ETAP Software
4. Fundamentals of Python: First Programs Author: Kenneth Lambert Publisher: Course
5. Technology, Cengage Learning, 2012 ISBN-13: 978-1-111-82270-5
6. Open source development tool guide.

Syllabus of Semester I

M. Tech (Power Electronics & Power System)

Course Code : EET556 **Course : FACTS and HVDC Transmission**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 04**

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 : Differentiate topology of HVDC and HVAC system and comparison with FACTS.

CO2 : Analyze working and performance of Graetz's bridge converter operation in various modes.

CO3 : Understand & Describe the application of filters to eliminate harmonics & design of smoothing reactor.

CO4 : To understand and describe operation of converters as a FACTS device.

CO5 : Apply shunt, series and their combination for compensation of AC Transmission line.

Syllabus:

- Performance of HVAC, HVDC versus HVAC Transmission, Comparison of FACTS and HVDC, converter configuration for HVDC.
- 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.
- 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.
- 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).
5. HVDC Transmission : S Kamakshaiah, V. Kamarojy

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.

Syllabus of Semester I

M. Tech (Power Electronics & Power System)

Course Code : HUP506 **Course : Professional Communication and Employability Skills**

L: 0 Hrs, P: 2 Hrs. Per week **Total Credits : 1**

Course Objectives

The course aims to develop professional spoken, written and employability skills of students; and enable them to face professional situations with enhanced confidence.

Course Outcomes

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

CO1 : Students learn public speaking and presentation skills

CO2 : Students learn to practice effective strategies for group discussion and personal interviews

CO3 : Students acquire proficiency in professional writing

CO4 : Students will be able to take apt decisions and perform as better professionals

List of Practical (2 Hours each)

Practical sessions -1: Professional Communication

1. Speaking Skills:

   Orientation & Practice in Public Speaking- I
2. Speaking Skills:

   Practice in Public Speaking – II
3. Presentation Skills:

   Orientation & Practice (Verbal and Non-verbal Communication)
4. Presentation Skills:

   Orientation & Practice (Visual Aids)

Practical sessions -2: Employability Skills

5. Group Discussion: Orientation & Practice
6. Group Discussion: Mock Sessions
7. Personal Interviews: Orientation (SWOT Analysis, Creating dynamic resumè & LinkedIn profile, effective usage of portals like www.indeed.com and www.glassdorr.co.in for job purposes)
8. Personal Interviews: Mock Session

Practical sessions -3: Interpersonal Communication & Generic Skills (Post-employability)

The following practicals will involve case studies, projects and MCQ-based assessments

9. Professional Writing: Orientation (ethics and gender neutrality in writing, letters, emails, memos, etc.)
10. Professional Writing: Practice
11. Time Management (Covey's Matrix, Prioritizing, Goal Setting, Tracking Progress)
12. Self-responsibility & Adaptability

Assessment will be based on:

1. Teacher's Continuous Assessment – 30 Marks
2. Peer Evaluation – 10 Marks (Practical 2, Practical 4 and Practical 6)
3. Self-analysis and report writing – 10 Marks (at the end of each practical session). Students won't be asked to submit a journal on each practical but on each of the practical sessions.

Syllabus of Semester II
M. Tech (Power Electronics & Power System)

Course Code : EET557 **Course : Advanced Drives**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 4**

Course Objectives

1. To understand various types of mechanical loads, flywheels used and the equivalent torque and inertia\ reflected on driving system.
2. To understand the conventional AC and DC drives.
3. To understand control methods for high performance applications and modern drives.

Course Outcomes

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

CO1 : Understand the nature of load torque, apply stability considerations and select an electric motor of appropriate rating.

CO2 : Describe the scalar control of induction motor and conservation of energy when driving fan or pump type load.

CO3 : Understand the working of high performance methods for induction motor control like FOC, DTC and speed-sensorless control.

CO4 : Describe the working of phase controlled and chopper controlled DC drive and associated aspects.

CO5 : Understand the working of special motor drives like SRM, BLDC motor and PMSM drive. CO6. Understand the working of solar and battery powered drives.

Syllabus

Dynamics of Electric Drive : Basic elements of electric drive, classification of electric drive, types of load torque, components of load torque*, selection of motor torque and power rating, stability considerations of electric drive.

DC Motor Drive : Steady state characteristics, speed control*, Phase Controlled DC motor drive, Chopper Controlled DC Motor Drive, four quadrant operations.

3-Phase Induction Motor Drive : Stator voltage control, frequency control, VVVF control, energy conservation by using VFD, slip-energy recovery scheme. abc to qe-de transformation and vice-versa, dynamic modeling of induction machine, Vector control (FOC): a qualitative examination, direct and indirect vector control, concept of voltage space vector, direct torque control (DTC), concept of speed-sensorless control**, Model Reference Adaptive System (MRAS) for speed-sensorless control.

Special Motor Drives : Switched reluctance motor (SRM): construction, variation of phase inductance with rotor position, torque and control; Synchronous machine with PMs: different topologies of rotor, development of sinusoidal and trapezoidal emfs, hall effect sensor, BLDC motor drive, control strategies.

Solar and Battery Powered Drives : Solar PV panels, solar powered pump drives, battery powered vehicles.

Text books

1. Dubey G. K. "Fundamentals of Electric Drives," Narosa Pub. House (2013).
2. Bose B. K. "Power Electronics & AC Drives," PHI Learning Pvt. Ltd. (2013).
3. Krishnan R. "Electric Motor Drives, Modelling, Analysis & Control," Pearson Edn. (2003).

Reference books

1. Krause P.C. "Analysis of Electrical Machinery," McGraw(1987).
2. Vas P. "Vector Control of AC Machines," Clarendon Press (1990).
3. Leonhard W. "Control of Electric Drives," Narosa Pub. House, (1984).
4. Teller T. J. E. "Brushless Permanent Magnet & Reluctance Motor Drives," Clarendom Press (1989).
5. Bridges &, Nasar S. A., "Electric Machine Dynamics," Macmilan Pub. Co. (1986).
6. Related IEEE Transaction paper

Syllabus of Semester II

M. Tech (Power Electronics & Power System)

Course Code : EEP557 **Course : Advanced Drives Lab**

L: 0 Hrs, P: 2 Hrs. Per week **Total Credits : 1**

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.

Syllabus of Semester II

M. Tech (Power Electronics & Power System)

Course Code : EET558 **Course : Advanced Powers System Protection**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 4**

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

1. Review of Power system Protection philosophy & Relays.
2. Instrument Transformers for Relaying.
3. Design of Protection Schemes for Transmission Lines
4. Design of Bus bar Protection Scheme.
5. Introduction to Numerical Relays.
6. 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

Syllabus of Semester II
M. Tech (Power Electronics & Power System)

Course Code : EEP559 **Course : Energy Audit Lab**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 1**

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.

Syllabus of Semester II

M. Tech (Power Electronics & Power System)

Course Code : EET560-1 **Course : Power Quality**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 4**

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).

Syllabus of Semester II
M. Tech (Power Electronics & Power System)

Course Code : EET560-2 **Course : Digital Signal Processing**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 4**

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.

Syllabus of Semester II

M. Tech (Power Electronics & Power System)

Course Code : EET560-3 **Course : Hydrogen Energy and Fuel Cell**

L: 4 Hrs, T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 4**

Course Objectives

The course is designed to provide the fundamental concept of hydrogen energy and Fuel Cell and relevant applications of fuel cell technology.

Course Outcomes

At the end of this course students will be able to

CO1 : Understand the use of Hydrogen as a energy storage

CO2 : Understand the basics and operation of fuel cell

CO3 : Evaluate the performance hydrogen fuel cell

CO4 : Discuss the use of Hydrogen Fuel Cell for different applications.

CO5 : Discuss about the Hydrogen storage and safety aspects.

Syllabus

Introduction to Hydrogen Energy : Hydrogen as a source of energy, physical and chemical properties, properties of hydrogen as fuel, introduction to infrastructure requirement for hydrogen production, storage, transportation and hydrogen economy.

Fuel Cells : Principle, working ,thermodynamics and kinetics of fuel cell process, types of Fuel Cell – Merits and Demerits, Nernst equation, performance evaluation of fuel cell.

Fuel Cell Design and Performance : Utilization percentages of fuels and oxygen, mass transfer effect, ohmic resistance, kinetic performance, fuel stack, polarization of PEMFC.

Application of Fuel Cell : Fuel Cell usage for domestic power systems, large scale power generation, automobile, future trends of Fuel Cell.

Hydrogen Storage and Safety : General storage methods, compressed gas, liquid hydrogen, hydride, chemical storage, safety and management of hydrogen.

Test Books

1. Vishwanathan,B and M Aulice Scibioh, Fuel Cells – Principles and Applications, Universities Press.
2. Bent Sorensen,Hydrogen and Fuel cell: Emerging Technologies and Applications; Elsevier Academic Press (UK)
3. James Larminie and Andrew Dicks; Fuel Cell Systems Explained by, John Wiley and Sons.
4. Frano Barbir, PEM Fuel Cells : Theory and Practice , Elsevier Academic Press (UK)

Syllabus of Semester II

M. Tech (Power Electronics & Power System)

Course Code : EET560-4 **Course : IoT and It's Applications in Energy Sector**

L: 4 Hrs, T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 4**

Course Outcomes

At the end of this course students will be able to

CO1 : Understand the basic blocks and applications of IoT.

CO2 : Understand different communication protocols used in IoT systems.

CO3 : Understand the necessity of IoT in energy sector

CO4 : Understand the architecture of IoT system used for energy infrastructure.

CO5 : Appreciate the use of IoT in various energy related applications.

Syllabus

Introduction to IoT : Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & Application, Programming Interface, Benefits of IoT.

IoT Connectivity : Wireless communication: RF,Wi-Fi, ZIGBEE, Bluetooth Low energy, LORA, Wired communication: RS485,Ethernet,

IoT as a Solution to Energy-Management : Introduction to Energy-Management Change Drivers, The Need for a Technical solutions, eIoT as an Energy-Management

IoT Within Energy Infrastructure : Introduction to Network-Enabled Physical Devices: Sensors and Actuators, Communication Networks, Distributed Control and Decision making, Architectures and Standards, Socio-Technical Implications of eIoT

Energy Applications of eIoT : Concept of Transactive Energy, Potential eIoT Energy-Management Use Cases, Applications for Utilities and Distribution System Operators, Energy IoT applications in Industrial, Commercial Applications and Residential sector

Role of IoT in transformation of Future grid.

Test Books

1. Internet of Things by Rajkamak, McGraw Hills Publications
2. eIoT- The Development of the Energy Internet of Things in Energy Infrastructure, by Steffi O. Muhanji, Alison E. Flint, Amro M. Farid Infrastructure, Springer Open access publication

Reference material

1. Research papers

Syllabus of Semester II
M. Tech (Power Electronics & Power System)

Course Code : EET563 | **Course : Microcontroller Applications in Power Converter and Power System**

L: 4 Hrs, T: 0 Hrs. P: 0 Hrs. Per week | **Total Credits : 4**

Course Pre-requisites

1. Microcontrollers
2. Advanced Power Electronics
3. Elementary knowledge of Power System

Course Objectives

The objective of this course introduce the use of microcontroller for development of various applications in power converters and power systems.

Course Outcomes

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

CO1 : Design signal conditioning circuit required in microcontroller based control.

CO2 : Design hardware for microcontroller based power converters.

CO3 : Implement control scheme used in microcontroller based controllers.

CO4 : Discuss the use of Microcontroller in basic numeric protective relays.

Syllabus

Signal conditioning circuits : Clipper, clampers, zero crossing detectors, level shifters, Filters, Compensators, Sensor interfacing for measurement of electrical quantities,

Control applications : PWM control, Implementation of hysteresis control, PI,PID control

Application in Power supplies : Control of DC-DC converters, Inverter control, SPWM Technique,

Applications in electric motor drives : DC motor control, Induction motor control, BLDC motor control

Applications in Power system : Introduction to schemes for basic Numerical Protective relays, flow charts- programming.

Text Books

1. The AVR microcontroller and Embedded systems using assembly and C, Muhammad Ali Mazdi, Sarmad Naimi and Sepher Naimi 2011, Prentice Hall.
2. PIC Microcontroller and Embedded Systems: Using Assembly and C: for MC18 by Muhammad Ali Mazidi, Sarmad Naimi and Sepehr Naimi. Pearson Custom Electronics Technology
3. Modern Power Electronics and AC Drives: B.K.Bose, Prentice Hall; First edition.
4. Digital Power System Protection,: S.R.Bhide, PHI Learning

References

1. Data sheets of hardware components

Syllabus of Semester II
M. Tech (Power Electronics & Power System)

Course Code : ENT560 **Course : VLSI Design Automation**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 4**

Course Objectives

The objective of this course is to provide students with:

1. Fundamental Knowledge of VLSI CAD tools chain and physical design flow.
2. Supporting knowledge of Algorithmic Graph Theory & Combinatorial Optimization
3. Techniques of Partitioning, floor-planning, placement and placement and routing
4. Basic information about static Timing Analysis to analyze designed circuits.

Course Outcomes

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

1. Describe the VLSI design flow and various VLSI design styles in detail.
2. Use algorithmic graph theory and combinatorial optimization techniques, as per requirement, to correctly formulate and solve VLSI design problems.
3. Explain the algorithms for partitioning, floor planing, placement and routing of VLSI circuits and use them to solve simple VLSI design problems.
4. Describe the process of Static Timing Analysis of VLSI circuits.

Syllabus

Introduction to VLSI CAD : VLSI design methodologies, use of VLSI CAD tools, VLSI Physical Design flow. Algorithmic Graph Theory & Combinatorial Optimization : Graph Terminology, Computational Complexity, depth First Search, Breadth First search, Dijkstra's Shortest path algorithm, Krusal and Prim's algorithm for Minimum Spanning trees, Travelling Salesman problem, Integer Linear Programming, (ILP), Simulated Annealing (SA)

Partitioning : Introduction, Types of Partitioning, Classification of partitioning algorithms.

Floorplanning : Introduction, Rectangular Dual Graph (RDG), Sliced and non-sliced floorplanning, Polish expression, Normalized Polish expression, Simulated Annealing.

Placement : Introduction, Classification of Placement Algorithms: Simulated Annealing/ Timberwolf algorithm (SA/TW), Simulated Evolution (SE), Force Directed Placement algorithm, Partition based placement algorithms.

Routing : Gird routing : Maze running algorithms, Line Searching algorithms, Steiner Tree algorithms, Global Routing; Graph models, routing algorithms, Detailed Routing : Two-layer Channel routing

algorithms : Left Edge Algorithms, Constraint-graph based algorithms, Greedy channel routerm hierarchical channel router, Switchbox routing, Clock Routing and Power / Ground Routing.

Static Timing Analysis and Timing Closure

Text Books

1. Algorithms for VLSI Design Automation: Sabih H. Gerez and John Wiley.(1998).
2. Algorithms for VLSI Physical Design Automation: Naveed Sherwani, Kulwer Academic Pub. (1999).

Reference Books

1. An introduction to VLSI Physical Design : Majid Sarrafzadesh and C. K. Wong, McGraw Hill, (1996)
2. Introduction to Algorithms : Thomas Corment et.al., The MIT Press, (2009)

Syllabus of Semester II
M. Tech (Power Electronics & Power System)

Course Code : CST561-1 **Course : Optimization Techniques in Artificial Intelligence**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 4**

Course Outcomes

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

CO1 : Learn how biological systems exploit natural processes.

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

CO3 : Solve optimization problem by using evolutionary & Natural computation.

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. Genetic algorithms: 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.ecs.utk.edu/ ~ mclennan/Classes/420/
3. http://www.cs.strir.ac.uk./courses/31YB/

Syllabus of Semester II
M. Tech (Power Electronics & Power System)

Course Code : CST561-2 **Course : Social Network Analysis**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 4**

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,

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.

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.

Syllabus of Semester II
M. Tech (Power Electronics & Power System)

Course Code : EET599 | **Course : Energy Management System**

L: 3 Hrs, P: 0 Hrs. Per week | **Total Credits : 3**

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.beeinida.in/: Bureau of Energy Efficiency.

Syllabus of Semester III
M. Tech (Power Electronics & Power System)

Course Code : EET651-2 **Course : Electric Vehicles**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 4**

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.

Text Books

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

Syllabus of Semester III
M. Tech (Power Electronics & Power System)

Course Code : EET651-3 **Course : Renewabel Power Generation Sources**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 4**

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

Syllabus of Semester III
M. Tech (Power Electronics & Power System)

Course Code : EET651-4 **Course : Electrical Power Distribution and Smart Grid**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 4**

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

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

Syllabus of Semester III

M. Tech (Power Electronics & Power System)

Course Code : EET652-1 **Course : Power System Dynamics and Control**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 4**

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 fortr a n s ie n t 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

Syllabus of Semester III

M. Tech (Power Electronics & Power System)

Course Code : EET652-4 **Course : Digital and Optimal Control System**

L: 4 Hrs, T: 0 Hrs, P: 0 Hrs. Per week **Total Credits : 4**

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 : Analyse the discrete time control systems with MATLAB programming and simulation.

CO2 : Design the state feedback controllers.

CO3 : Apply different stability analysis techniques to analog and digital systems.

CO4 : Optimize the system to achieve desired performance.

Syllabus

Digital Control System : Representation of SDCS. Sample & Hold Circuit. Z- Transform. Inverse ZTransform & solution of difference equation. Z & S domain relationship. Comparison of time response of continuous and digital control systems, Effect of sampling period on transient response characteristic Discritization of continuous time state equation. Solution of Discrete time state equations. Controllability & Obervability of discrete time systems.

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.

Stability Analysis : Stability by bilinear transformation & Jury's test, Stability of Equilibrium State in the Sense of Liapunov; Liapunov's Stability Test, Second Method of Liapunov; Liapunov Function Based on Aizerman's Method,

Optimal Control System : Calculus of Variation, the Lagrangian and Hamilton Functions.

Text Books

1. Digital control and State variable Methods, Fourth Edition, Mc Graw Hills, M Gopal
2. Modern Control system theory, Third Edition, New Age International Publishers, M. Gopal
3. Modern Control Engineering, Fourth Edition, Prentice Hall, 2001 - Katsuhiko Ogata.
4. Automatic Control Systems, High Education Press, 2003 - B. C. Kuo
5. Control Systems Engineering, Fifth Edition, New Age International Publishers, 2007 J. Nagrath & M Gopal

Syllabus of Semester III

M. Tech (Power Electronics & Power System)

Course Code : EET652-5 **Course : Power System Modeling and Analysis**

L: 4 Hrs, P: 0 Hrs. Per week **Total Credits : 4**

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- 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.

Syllabus of Semester III

M. Tech (Power Electronics & Power System)

Course Code : EEP653 **Course : Circuit Simulation and Hardware Implementation Lab**

L: 0 Hrs, P: 4 Hrs. Per week **Total Credits : 2**

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.

Syllabus of Semester III

M. Tech (Power Electronics & Power System)

Course Code : EEP654 **Course : Project Phase - I**

L: 0 Hrs, P: 3 Hrs. Per week **Total Credits : 6**

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

Syllabus of Semester IV

M. Tech (Power Electronics & Power System)

Course Code : EEP655 **Course : Project Phase - II**

L: 0 Hrs, P: 6 Hrs. Per week **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

NOTES