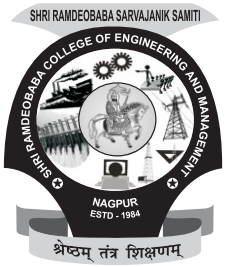

SHRI RAMDEOBABA COLLEGE OF ENGINEERING AND MANAGEMENT, NAGPUR – 440013

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

PROGRAMME SCHEME & SYLLABI
2021 – 2022

B.Tech. (ELECTRICAL ENGINEERING)

Published By

Dr. R. S. Pande

Principal
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Ph. : 0712-2580011 Fax : 0712 - 2583237
ISO 9001 : 2015 CERTIFIED ORGANISATION

Salient Features of the Department

- The Department of Electrical Engineering was established in the year 1984 with a sanctioned UG intake of 60 students. The National Board of Accreditation has accredited the department five times in succession in the year 2001,2006, 2012, 2017 and 2020. Presently, the Electrical Engineering Department also has a 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 eight Assistant Professors on 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 . The curriculum of both UG & PG programmes is as per choice based credit system and in line with AICTE model curriculum.
- To introduce the graduating students to the latest developments in the industry, the department organizes Technical Workshop cum Exhibition named “EMPOWER". This mega event was organized in the department for five times in year 2012, 2013, 2014, 2017 and 2018. Reputed companies namely ABB Limited, ARCTIC 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 during the vacation.

Department Vision

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 environement for students to achieve excellence in core electrical and multidisciplinary fields by synergetic efforts of all stake holders of the Electrical Engineering Department and inculcate the ethical and social values.

Program Educational Objectives

PEO1 : Our graduates will work on design, operation and practice in electrical fields by addressing intricacies of engineering and technology applications.

PEO2 : Our graduates will work in multidisciplinary fields and adapt to new technologies, new work environments, pursue additional skills and knowledge leading to professional development.

PEO3 : Our graduates will progress in their career by demonstrating in practice the technical and communication skills with an understanding of ethical and social responsibilities.

Program Outcomes

PO1. **Engineering knowledge :** Apply the knowledge of mathematics, science, engineering fundamentals to the solution of engineering problems.

PO2. **Problem analysis :** Identify, formulate, review literature, and analyze complex engineering problems using first principles of mathematics, natural sciences and engineering sciences.

PO3. **Design/development of solutions :** Design solutions for complex engineeing problems and design system components or processes that meet the specified needs with appropriate consideration for the public safety, societal and environmental considerations.

PO4. **Conduct problem investigations :** Use research-based knowledge including experimentation, analysis and interpretation of data and synthesis of the information to provide valid conclusions.

PO5. **Modern tool usage :** Select, and apply appropriate techniques, resources, and modern engineering and IT tools for analyzing the engineering activities with an understanding of the limitations.

PO6. **The engineer, industry and society :** Apply contextual knowledge to assess industrial, societal and safety related issues and understand consequent relevance to the professional engineering practice.

PO7. **Environment and sustainability :** Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

PO8. **Ethics :** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. **Individual and team work :** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication : Communicate effectively on complex engineering activities such as, being able to understand and write effective reports, make effective presentations and give and receive clear instructions.

PO11. Project management and finance : Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team in multidisciplinary environments.

PO12. Life-long learning : Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcomes

PSO1. Analyze and design electrical networks, machines, control systems, power systems, power converters and evaluate the performance.

PSO2. Understand and develop electrical systems considering energy efficiency, power scenario, environmental issues and industry applications.

Teaching Scheme for First Year (Semester I & II) Bachelor of Engineering
Group 1 : Semester - I / Group 2 : Semester - II

Sr. No.	Code	Course	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
			L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	PHT152	Oscillations, waves and Optics	3	1	0	4	40	60	100	03
2.	PHP152	Oscillations, Waves and Optics Lab	0	0	3	1.5	25	25	50	–
3.	MAT152/ MAT151	Differential Equations, Linear Algebra, Statistics & Probability/ Calculus	3	0/1	0	3/4	40	60	100	03
4.	MAP151	Computational Mathematics Lab	0	0	2	1	25	25	50	–
5.	EET151	Basic Electrical Engineering	3	1	0	4	40	60	100	03
6.	EEP151	Basic Electrical Engineering Lab	0	0	2	1	25	25	50	–
7.	MET151	Engineering Graphics and Design	1	0	0	1	40	60	100	03
8.	MEP151	Engineering Graphics and Design Lab	0	0	4	2	50	50	100	–
9.	HUT152	Constituation of India	2	0	0	0	–	–	–	–
10.	PEP151	Yoga / Sports	0	0	2	0	–	–	–	–
		TOTAL	**12**	**2/3**	**13**	17.5/18.5				

Group 2 : Semester - 1 / Group 1 : Semester - II

Sr. No.	Code	Course	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
			L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	CHT151	Chemistry	3	1	0	4	40	60	100	03
2.	CHP151	Chemistry Lab	0	0	3	1.5	25	25	50	–
3.	MAT151/ MAT152	Calculus/Differencial Equations, Linear Algebra, Statistics and Probability	3	1/0	0	4/3	40	60	100	03
4.	CST151	Programming for Problem Solving	4	0	0	4	40	60	100	03
5.	CSP151	Programming for Problem Solving Lab	0	0	2	1	25	25	50	–
6.	IDT151	Creativity, Innovation and Design Thinking	1	0	0	1	20	30	50	1.5
7.	INT151	Workshop/Manufacturing Practices	1	0	0	1	20	30	50	1.5
8.	INP151	Workshop/Manufacturing Practices Lab	0	0	2	1	25	25	50	–
9.	HUT151	English	2	0	0	2	40	60	100	03
10.	HUP151	English Lab	0	0	2	1	25	25	50	–
		TOTAL	**14**	**2/1**	**9**	**20.5/19.5**				

Scheme of Teaching & Examination of Bachelor of Engineering (Electrical Engineering)

Semester III

Sr. No.	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
			L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	MAT256	Electrical Engineering Mathematics	3	0	0	03	40	60	100	3
2.	CET271	Engineering Mechanics and Strength of Materials	3	0	0	03	40	60	100	3
3.	EET251	Network Analysis	3	1	0	04	40	60	100	3
4.	EEP251	Network Analysis Lab	0	0	2	01	25	25	50	3
5.	ENT259	Analog Electronic Circuits	3	0	0	03	40	60	100	3
6.	ENP259	Analog Electronic Circuits Lab	0	0	2	01	25	25	50	3
7.	EET252	Electrical Measurements and Instrumentation	2	1	0	03	40	60	100	3
8.	EEP252	Electrical Measurements and Instrumentation Lab	0	0	2	01	25	25	50	3
9.	HUT251	Principles of Economics and Management	3	0	0	03	40	60	100	3
10.	CHT251	Environmental Science	2	0	0	00	-	-	-	-
		TOTAL	**19**	**02**	**06**	**22**				

Semester IV

Sr. No.	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
			L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	EET271	Signals and Systems	2	1	0	03	40	60	100	3
2.	ENT260	Digital Circuits and Microprocessor	3	0	0	03	40	60	100	3
3.	ENP260	Digital Circuits and Microprocessor Lab	0	0	2	01	25	25	50	3
4.	EET272	Electrical Machines-I	3	1	0	04	40	60	100	3
5.	EEP272	Electrical Machines-I Lab	0	0	2	01	25	25	50	3
6.	EET273	Programming for EE Applications	3	0	0	03	40	60	100	3
7.	EEP273	Programming for EE Applications Lab	0	0	2	01	25	25	50	3
8.	EET299	Open Elective-I	3	0	0	03	40	60	100	3
9.	EET275	Electromagnetic Fields	3	0	0	03	40	60	100	3
10.	HUT252	Indian Traditional Knowledge	2	0	0	00	-	-	-	-
		TOTAL	**19**	**02**	**06**	**22**				

	Open Elective-I
EET299-1	Consumer Electrical Appliances
EET299-2	Renewable Energy Systems

(Electrical Engineering)

Semester V

Sr. No.	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
			L	T	P		Conti-nuous Evaluation	End Sem Exam	Total	
1.	EET351	Power System-I	3	0	0	03	40	60	100	3
2.	EET352	Electrical Machines-II	3	1	0	04	40	60	100	3
3.	EEP352	Electrical Machines-II Lab	0	0	2	01	25	25	50	3
4.	EET353	Microcontroller	3	0	0	03	40	60	100	3
5.	EEP353	Microcontroller Lab	0	0	2	01	25	25	50	3
6.	EET354	Program Elective-I	3	0	0	03	40	60	100	3
7.	EET355	Power Electronics	3	1	0	04	40	60	100	3
8.	EEP355	Power Electronics Lab	0	0	2	01	25	25	50	3
9.	EET398	Open Elective-II	3	0	0	03	40	60	100	3
10.	EEP357	Electrical Workshop and CAEED Lab	0	0	2	01	25	25	50	3
		TOTAL	**18**	**02**	**08**	**24**				

Program Elective-I		**Open Elective-II**	
EET354-1	Electrical Machine Design	EET398-1	Energy Management and Audit
EET354-2	Non Conventional Energy Sources	EET398-2	Microcontroller Applications
EET354-3	Electrical Energy Conservation and Audit	EET398-3	Industrial Instrumentation
EET354-4	Industry Offered Elective-I		

Semester VI

Sr. No.	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
			L	T	P		Conti-nuous Evaluation	End Sem Exam	Total	
1.	EET371	Power System –II	3	0	0	03	40	60	100	3
2.	EEP371	Power System –II Lab	0	0	2	01	25	25	50	3
3.	EET372	Control Systems	3	1	0	04	40	60	100	3
4.	EEP372	Control Systems Lab	0	0	2	01	25	25	50	3
5.	EET373	Program Elective-II	3	0	0	03	40	60	100	3
6.	EET374	Program Elective-III	3	0	0	03	40	60	100	3
7.	EET399	Open Elective-III	3	0	0	03	40	60	100	3
8.	EEP376	E-Circuit Design and Testing Lab	0	0	2	01	25	25	50	3
9.	EEP377	Comprehensive Viva	0	0	2	01	25	25	50	3
		TOTAL	**15**	**01**	**08**	**20**				

Program Elective-II		Program Elective-III		Open Elective-III	
EET373-1	PLC and SCADA	EET374-1	Electrical Drives and Control	EET399-1	Solar Photovoltaic Systems
EET373-2	Power Station Practice	EET374-2	HVDC Transmission Systems		
EET373-3	Utilization of Electrical Energy	EET374-3	Industry Offered Elective-III	EET399-2	Automation with PLC
EET373-4	Industry Offered Elective-II	IDT353	Biology for Engineers		
		EET374-5	Photovoltaic System Engineering		

Semester VII

Sr. No.	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
			L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	EET451	High Voltage Engineering	3	0	0	03	40	60	100	3
2.	EEP451	High Voltage Engineering Lab	0	0	2	01	25	25	50	3
3.	EET452	Program Elective-IV	3	0	0	03	40	60	100	3
4.	EET498	Open Elective-IV	3	0	0	03	40	60	100	3
5.	MBT451	Entrepreneurship Development	3	0	0	03	40	60	100	3
6.	EEP454	Industry Internship Evaluation	0	0	2	00	50	-	50	-
7.	EEP455	Project Phase-I	0	0	6	03	100	-	100	-
		TOTAL	**12**	**00**	**10**	**16**				

Program Elective-IV		Open Elective-IV	
EET452-1	Advanced Electric Drives and Vehicles	EET498-1	Electric Vehicles
EET452-2	Computer Applications in Power System		
EET452-3	Advanced Control Systems	EET498-2	Industrial IOT Instrumentation and Connectivity
EET452-4	EHVAC Transmission Systems		
EET452-5	Industry Offered Elective-IV		
EET452-6	Electric Vehicles and Energy Storage System		

Semester VIII

Sr. No.	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
			L	T	P		Continuous Evaluation	End Sem Exam	Total	
1.	EET472	Program Elective - V	3	0	0	03	40	60	100	3
2.	EET473	Program Elective - VI	3	0	0	03	40	60	100	3
3.	EEP474	Project Phase - II	0	0	16	08	100	100	200	3
4.	EET475	Program Elective - VII	3	0	0	03	40	60	100	3
5.	EEP475	Program Elective - VIII	0	0	2	01	25	25	50	-
		TOTAL	**09**	**00**	**18**	**18**			**550**	
		OR								
	EEP476	Full Semester Internship (Industry/Research/TBI)			16	18	100	100	200	
					16	**18**	**100**	**100**	**200**	

Program Elective - V		Program Elective - VI	
EET472-2	EHV Substation Design and Erection	EET473-1	Power Quality
EET472-3	Mechatronics	EET473-2	Industrial Electrical Systems
EET472-4	Industry Offered Elective - V	EET473-3	Fuzzy Logic and Neural Networks
EET472-5	FACTS	EET473-4	Industry Offered Elective - II

Program Elective - VII		Program Elective - VIII	
EET475-1	Power System Protection	EEP475-1	Power System Protection Lab
EET475-2	Digital Signal Processing	EEP475-2	Digital Signal Processing Lab
EET475-3	Industry Offered Elective - VII		

Honors & Minor Scheme

List of the courses under Honor Specialization

Sr. No.	Semester	Course code	Course Name	Hours per week	Credits	Maximum marks			ESE Duration (Hrs)
						Continuous Evaluation	End Sem Exam	Total	
1.	IV	EETH41	DC Microgrid	4	4	40	60	100	3
2.	V	EETH51	Introduction to Smart Grid	4	4	40	60	100	3
3.	VI	EETH61	Advanced Power Electronics	4	4	40	60	100	3
4.	VII	EETH71	Mathematical Methods and Techniques in Signal Processing	4	4	40	60	100	3
5. 6.	VIII (Any	EETH81-1	Advanced Linear Continuous Control Systems: Applications with MATLAB Programming and Simulink	4	4	40	60	100	3
7.	one	EETH81-2	Mapping Signal Processing Algorithms to DSP Architectures	4	4	40	60	100	3
8.	out	EETH81-3	Power System Analysis	4	4	40	60	100	3
	of 4)	EETH81-4	Power System Dynamics, Control and Monitoring	4	4	40	60	100	3

List of the courses under Minor Specialization

Sr. No.	Semester	Course code	Course Name	Hours per week	Credits	Maximum marks			ESE Duration (Hrs)
						Continuous Evaluation	End Sem Exam	Total	
1.	IV	EETM41	Electrical Machines	4	4	40	60	100	3
2.	V	EETM51	Power Semiconductor Based Drives	4	4	40	60	100	3
3.	VI	EETM61	Renewable Energy Sources	4	4	40	60	100	3
4.	VII	EETM71	Power System	4	4	40	60	100	3
5.	VIII	EETM81	Power System Protection	4	4	40	60	100	3

Syllabus for Semester BE I / II
Bachelor of Mechanical Engineering, Electrical Engineering

Course Code : PHT152 **Course : Oscillations, Waves, Optics**

L:3 Hrs.,T:1Hrs.,P : 0Hrs.,Per week **Total Credits : 4**

Course Objectives

1. To train the student to work with oscillatory phenomena in electrical, mechanical and optical systems;
2. To introduce fundamental concepts and laws as relevant to electromagnetic waves and matter waves.

Course Outcomes

After successful completion of the course students will understand and be able to work with

1. Free, damped and forced oscillations;
2. Fundamental properties of mechanical waves and their propagation across material boundaries;
3. Basics of electromagnetic waves and optical media, phenomena of interference, diffraction of optical waves
4. Elementary understanding of quantum behavior of electrons in solids.

Module 1: Oscillations (8L)

Quick review of simple harmonic motion, mechanical and electrical oscillators, vector and complex number (phasor) representation, superposition of many SHMs of equal amplitude and equal successive phase difference; Damped oscillations, under, critical and over-damping with stress on mechanical oscillators, problems; Forced oscillations with focus on electrical/mechanical oscillations, impedance of a electrical/mechanical circuit, forcing frequency dependence of velocity, displacement in a forced oscillator, two components of displacement, energy and power supplied by driving force, Q factor.

Module 2: Waves - 1 (5L)

Correlated harmonic oscillations in space and time, statement and meaning of the wave equation, general solution, concept of polarization of waves- transverse and longitudinal waves; Transverse wave on a string, characteristic impedance, reflection and transmission at a string-string boundary, impedance matching, insertion of quarter-wave element.

Module 3: Waves - 2 (5L)

Group of waves, group velocity, meaning of dispersion, causes of dispersion; Standing waves, normal modes of vibrating string, energy in modes, standing wave ratio; Longitudinal waves: sound waves in gases, statement and meaning of expressions for energy distribution and intensity.

Module 4: Wave Optics - 1 (6L)

Light as a transverse polarized electromagnetic wave in vacuum and in homogeneous isotropic dielectric, impedance |E|/|Hperp,E|, Poynting vector, energy; Reflection and refraction of em wave at dielectric-dielectric boundary, parallel and perpendicular polarizations, boundary conditions on E and H components, Fresnel equations, Brewster's angle.

Module 5: Wave Optics - 2 (6L)

Huygens' principle, superposition, interference by division of amplitude and wavefront, Young's double- slit, Newton's rings, Michelson interferometer; Single-slit Fraunhofer diffraction, Rayleigh criterion for resolution, grating and its resolving power.

Module 6: Matter Waves (8L)

Plank's energy packets, Wave-particle duality of de Broglie, Heisenberg uncertainty relations; Wave function for matter waves and its interpretation, position and momentum operators, Hamiltonian operator, Schrodinger's equation; One-dimensional single particle systems: Particle in a infinite square well potential (rigid box), Finite square well potential; Quantum tunneling.

Text Book(s)

1. The Physics of Vibrations and Waves (Sixth Edition), H J Pain John-Wiley 2005.
2. Optics, Ajoy Ghatak, Tata McGraw Hill Education 2005

References

1. Online course: Oscillations and Waves by S Bharadwaj on NPTEL
2. Engineering Physics (Second Edition), Sanjay Jain and Girish Sahasrabudhe, Universities Press 2016.

Syllabus of Physics Lab for Semester I/II,
(Semester-I: Electrical Engineering, Semester-II: Mechanical Engineering)

Course Code : PHP152 **Course : Oscillations, Waves, Optics lab**

L: 0 Hrs. T: 0 Hrs. P: 3 Hrs. Per week **Total Credits : 1.5**

Course Outcomes

The Physics Laboratory course will consist of experiments illustrating the principles of physics relevant to the study of science and engineering. Students will show that they have learnt laboratory skills that will enable them to properly acquire and analyze the data in physics laboratory and draw valid conclusions. At the end of the Course the students will learn to:

1. Develop skills to impart practical knowledge in real time.
2. Understand principle, concept, working and application of areas in physics and compare the results obtained with theoretical calculations.
3. Understand measurement technique, and report the results obtained through proper graph plotting and error analysis.

In addition to the demo experiments, the Lab turns will be utilized for performing the experiments based on the following lists as specific to Program:

1. Error analysis and graph plotting
2. Wave length, frequency and phase velocity of travelling wave.
3. Wavelength of source of light using Newton's rings
4. To study the oscillation in bifilar suspension arrangement
5. Determination of velocity of sound in liquid–standing ultrasonic waves as optical grating
6. Kundt's tube – Determination of the wavelength of sound with the cork powder method
7. Determination of velocity of sound in solid
8. Beating of ultrasonic waves
9. Investigation of Doppler effect with ultrasonic waves
10. Refractive Index of prism
11. Frequency, amplitude and phase determination using C.R.O.
12. Study of surface flatness using interference phenomena
13. To determine the resolving power of grating
14. Study of Polarizers and Analyzers
15. Study of total internal reflection using Laser source
16. Data analysis using Mathematica

Suggested References

1. Physics Lab Manual written by the Teaching Faculty of Physics Department, RCOEM. A minimum of 8 experiments are to be performed from the above list of experiments.

Syllabus for B.E. Semester I

Course Code : MAT151 **Course : Calculus**

L: 3 Hrs., T: 1 Hrs., P: 0 Hrs., Per week **Total Credits : 04**

Course Objective

The objective of this course is to familiarize the prospective engineers with techniques in Calculus and multivariate analysis. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

Course Outcomes

On successful completion of the course, the students will learn:

1. The fallouts of Mean Valve Theorems that is fundamental to application of analysis to Engineering problems, to deal with functions of several variables that are essential in most branches of engineering.
2. Basics of improper integrals, Beta and Gamma functions, Curve Tracing, tool of power series and Fourier series for learning advanced Engineering Mathematics.
3. Multivariable Integral Calculus and Vector Calculus and their applications to Engineering problems.

Syllabus

Module - I : Differential Calculus: (12hours)

Taylor's and Maclaurin's series expansions; radius of curvature (Cartesian form), evolutes and involutes, Limit and continuity of functions of several variables and their partial derivatives, Eulers Theorem, chain rule, total derivative, Jacobians, Maxima, minima and saddle points; Method of Lagrange multipliers.

Module - II : Integral Calculus: (6 hours)

Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Tracing of curves (Cartesian form)

Module - IV : Sequences and series: (7 hours)

Convergence of sequence and series, tests for convergence, power series, Fourier series: Half range sine and cosine series, Parseval's theorem.

Module - V : Multiple Integrals (10 hours)

Multiple Integration: Double and triple integrals (Cartesian and polar), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: area, mass and volume by double integration, Center of mass and Gravity (basic concepts).

Module - VI : Vector Calculus (10 hours)

Vector Differentiation, Directional derivatives, total derivative, Gradient, Curl and Divergence. Vector integration , Theorems of Green, Gauss and Stokes and their applications.

Topics for self learning

Rolle's theorem, Mean value theorems, Indeterminate forms , Maxima and minima for function of one variable, Geometrical interpretation of Partial Differentiation(Tangent plane and Normal line) , Applications of definite integrals to evaluate perimeter, area, surface areas and volumes of revolutions.

Textbooks/References

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
5. P. N. Wartikar and J. N. Wartikar, A text book of Applied Mathematics Volume I & II, Pune Vidhyarthi Griha Prakashan, Pune-411030 (India).

Syllabus for B.E. Semester II

Course No. MAT152 **Course : Differential Equations, Linear Algebra, Statistics and Probability**

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

Course Objective

The objective of this course is to familiarize the prospective engineers with techniques in Ordinary differential equation, statistics, probability and Matrices.

It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

Course Outcomes

On successful completion of the course, the students will learn:

1. The effective mathematical tools for the solutions of ordinary differential equations that model physical processes.
2. The essential tool of matrices in a comprehensive manner.
3. The ideas of probability and various discrete and continuous probability distributions and the basic ideas of statistics including measures of central tendency, correlation and regression.

Syllabus

Module 1:First order ordinary differential equations(7 hours)

Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree : equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Module 2: Ordinary differential equations of higher orders (8 hours)

Second order linear differential equations with constant and variable coefficients, method of variation of parameters, Cauchy-Euler equation.

Module 3:Basic Statistics: (7 hours)

Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves, correlation and regression – Rank correlation, Multiple regression and correlation.

Module 4: Basic Probability: (8 hours)

Probability spaces, conditional probability, independence; Discrete random variables, Binomial distribution, Poisson distribution, Normal distribution. Relation between binomial, Poisson and Normal distributions.

Module 5: Matrices (10 hours)

Algebra of matrices, Inverse and rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Eigen values and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, Orthogonal transformation and quadratic to canonical forms.

Topics for Self Learning

Application of Differential Equations.

Textbooks/References

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India, 2009.
3. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
4. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
5. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
7. Theory and Problems of probability and statistics : 2nded :J. R. Spiegal ,Schaum series
8. A text book of Applied Mathematics Volume I & II, by P. N. Wartikar and J. N. Wartikar, Pune Vidhyarthi Griha Prakashan, Pune-411030 (India).
9. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.

Syllabus of Mathematics Computational Lab for Semester I/II, B.E. (2018-19)

Course Code : MAP151 **Course : Computational Mathematics Lab**

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

Course Outcomes

The Computational Mathematics Lab course will consist of experiments demonstrating the principles of mathematics relevant to the study of science and engineering. Students will show that they have learnt laboratory skills that will enable them to properly acquire and analyze the data in the lab and draw valid conclusions. At the end of the Course the students will learn to:

1. Develop skills to impart practical knowledge in real time.
2. Understand principle, concept, working and application of areas in mathematics and compare the results obtained with theoretical calculations.
3. Understand basics of mathematics, and report the results obtained through proper programming.

The Lab turns will be utilized for performing the experiments based on the following list:

1. Calculus
2. Ordinary Differential Equations
3. Statistics
4. Linear Algebra

Suggested References:

1. Computational Mathematics Lab Manual written by the Teaching Faculty of Mathematics Department, RCOEM.

A minimum of 8 experiments to be performed based on the above list.

Syllabus of Group 1 - Semester I and Group 2 - Semester II, Bachelor of Engineering

Course Code : EET151 Course : Basic Electrical Engineering

Course Outcomes

At the end of this course, students will demonstrate the ability

CO1: Understand and analyze basic ac and dc electric circuits and magnetic circuits

CO2: Understand working principles of electrical machines: Transformer, Induction motor, DC machines

CO3: Apply the knowledge of power converter for suitable applications

CO4: Introduce and identify the components of power systems and low-voltage electrical Installations.

Module 1: Introduction to Power system (2 hours)– CO4:

Introduction to Power Generation (Thermal, Hydro, Nuclear, Wind, and Solar) with block schematic presentation only. Single line diagram for Generation, Transmission & Distribution through different voltage levels.

Module 2 : DC Circuits & Magnetic Circuits(8 hours) - CO1:

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff's current and voltage laws, analysis of simple circuits with DC excitation, Time-domain analysis of first order RL and RC circuits, Magnetic materials, BH characteristics, Basics of Magnetic circuits.

Module 3: Single Phase AC Circuits (6 hours) - CO1:

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance.

Module 4: Three Phase AC Circuits (4 hours) - CO1:

Three phase AC generation, Three phase balanced circuits, voltage, and current relations in star and delta connections. Power factor improvement.

Module 5: Transformers (6 hours) - CO2:

Ideal and practical transformer, Equivalent circuit, losses in transformers, regulation, and efficiency. Auto transformer and three-phase transformer connections.

Module 6: Electrical Machines (8 hours) - CO2:

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components, efficiency, starting of induction motor. Single- phase induction motor. Construction, working, torque-speed characteristic, and speed control of separately excited dc motor.

Module 7: Power Converters (4 hours) - CO3:

Block schematic introduction to power converters and its practical applications (DC-DC, DC-AC, AC-DC, AC- AC), Types of Batteries, Important Characteristics for Batteries and battery backup.

Module 8: Electrical Installations (4 hours) - CO4:

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Elementary calculations for energy consumption, energy tariff.

Text / References

1. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
3. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
4. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
5. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.
6. Electrical Technology: B. L. Thereja, S. Chand Publications.
7. Basic Electrical Engineering: S. B. Bodkhe, N. M. Deshkar, P. P. H. Pvt. Ltd.

Syllabus of Group 1 - Semester I and Group 2 - Semester II, Bachelor of Engineering

Course Code : EEP151 **Course: Basic Electrical Engineering Lab.**

Course Outcomes

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

CO1: Co-relate, analyze and apply the fundamental principles of science and engineering to understand the laboratory experimental work.

CO2: Connect the electric circuit, perform the experiment, analyze the observed data and make valid conclusion.

CO3: Write report based on the performed experiments (journal) with effective presentation of diagrams and characteristics/graphs.

CO4: Carry out survey of electrical energy consumption at home and calculate monthly energy bill as per the tariff of power Distribution Company.

List of Experiments

1. To verify Kirchhoff's laws for D.C. Circuits
2. Verification of Kirchhoff's laws to AC circuit(RLC series)
3. Verification of Kirchhoff's laws to AC circuit (RLC parallel).
4. To study speed control of D.C. shunts motor by:
   a) Armature voltage Control method.
   b) Field current/flux control method.
5. To study the balanced Three phase system for star and delta connected balanced load.
6. Improvement of power factor by using static capacitors
7. To determine regulation and efficiency of a single phase transformer by open circuit (o.c) and short circuit (s.c.) tests.
8. To determine regulation and efficiency of a single phase transformer by direct loading test

Demonstration / Study experiment

9. To study B-H curve for different magnetic material
10. To study Buck converter
11. To study Boost converter

Demonstration of cut out sections of machines:

i. DC Machine
ii. Three phase squirrel cage induction motor
iii. Synchronous machine

Syllabus of Department of Mechanical Engineering

Course Code : MET151 **Course: Engineering Graphics and Design**

L:1 Hr., T:0Hrs., P:0 Hrs., Per week **Total Credits : 01**

Course Outcomes

The expected learning outcome is that, the students shall be able to

1. Draw and interpret technical drawing
2. Convert 2-D to 3-D drawing and vice versa.
3. Represent the various positions of planes and solids in different orientations.
4 Develop the solid surface for sheet metal working.

UNIT 1 : Introduction to Engineering Drawing

Principles of Engineering Graphics and their significance, usage of drawing instruments, Lettering and dimensioning.

UNIT 2 : Orthographic Projections

Principles of Orthographic Projections -Conventions : Projections of Points and lines (line inclined to both planes) Projections of planes (inclined to both the planes), Introduction to Auxiliary Planes;

UNIT 3 : Projections of Solids

Inclined to both the Planes - Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include : windows, doors, and fixtures such as WC, bath, sink, shower, etc.

UNIT 4 : Sections and Sectional Views of Right Angular Solids

Prism, Cylinder, Pyramid Cone-Auxiliary Views; Development of surface of Right Regular solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only)

UNIT 5 : Isometric Projections

Principles of Isometric projection - Isometric Scale, Isometric Views, Conventions; Isometric Views of Simple Solids; Conversion of Orthographic views to Isometric Views / Projection.

Suggested Text / Reference Books

i) Bhatt N. D. Panchal V.M. & Ingle P.R., (2014) Engineering Drawing, Charotar Publishing House.

ii) Jolhe D. A. (2016) Engineering Drawing with an Introduction to Auto CAD", Tata McGraw- Hill Publishing Co. Ltd., New Delhi.

iii) Narayana K. L. & P. Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.

iv) Shah M. B. & Rana B. C. (2008), Engineering Drawing and Computer Graphics, Pearson Education.

v) Agrawal B & Agrawal C. M. (2012), Engineering Graphic, TMH Publication.

vi) Corresponding set of CAD Software Theory and User Manuals.

Syllabus of Department of Mechanical Engineering

Course Code : MEP151 **Course : Engineering Graphics and Design Lab**

L:0 Hr., T:0Hrs., P:4 Hrs., Per week **Total Credits : 02**

Course Outcomes

Students are prepared for actual work situations through practical training in a new state of the art computer designed CAD laboratory using engineering software. The student will learn to :

1. Draw and interpret technical drawing
2. Plan the sheet layout for the given drawing
3. Convert 2-D to 3-D drawing and vice versa
4. Represent the various positions of planes and solids in different orientations.
5. Develop the solid surface for sheet metal working
6. Use & demonstrate drafting package.

UNIT 1 : Introduction to Engineering Drawing

Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloids, Hypocycloid and involutes; Introduction to Scales.

UNIT 2 : Orthographic Projections

Principles of Orthographic Projections -Conventions - Projections of Points and lines inclined to both planes; Projections of planes - Auxiliary Planes.

UNIT 3 : Projections of Solids

Inclined to both the Planes Auxiliary Views; Draw simple annotation, dimensioning and scale, Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.

UNIT 4 : Sections and Sectional Views of Right Angular Solids

Prism Cylinder, Pyramid, Cone - Auxilary Views; Development of surfaces of Right Regular Solids Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only)

UNIT 5 : Isometric Projections

Principles of Isometric projection - Isometric Scale, Isometric Views, Conventions; Isometric Views of Simple Solids; conversion of Orthographic views to Isometric views / Projection

UNIT 6 : Overview of Computer Graphics

Demonstrating knowledge of the theory of CAD software such as (the Menu System Toolbars Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, crosshairs, Coordinate Systems), Dialog boxes and windows, Shortcut menus (Button Bars), The command Line (wherever applicable), The Status Bar, Different methods of zoom as used in CAD, select and erase objects; Isometric Views of lines, Planes, Simple and compound solids);

UNIT 7 : Customization & CAD Drawing

Setting up drawing page and the printer, including scale settings, Setting up of units and Drawing limits; ISO and ANSI standards for coordinate dimensioning; Orthographic constraints, map to objects, manually and automatically, Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

UNIT 8 : Annotations Layering & Other Functions

Applying dimensions to objects, applying annotations to drawings; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques.

UNIT 9 : Demonstration of a simple team design project that illustrates

Geometry and Topology of Engineered Components Creation of Engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; Meshed toplogies for engineering, Introduction to Building Information Modeling (BIM), drafting and design package, 3D printing.

List of sheets

1. Curves (ellipse, Parabola, hyperbola, Cycloid, involute)
2. Line, Planes, Solids
3. Application of Section and development of solids
4. Orthographic Projection
5. Isometric
6. Auto CAD practice sheet 1
7. Auto CAD practice sheet 2
8. Blueprint sheet

Suggested Text/ Reference Books

i) Bhatt N.D. Panchal V.M. & Ingle P.R., (2014), Engineering drawing, Charotar Publiishing house

ii) Jolhe D.A., (2016) Engineering drawing with an Introduction to Auto CAD", Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

iii) Shah M.B. & Rana B.C. (2008), Engineering drawing and Computer Graphic, Pearson Education.

iv) Agarwal B & Agarwal C.M. (2012), Engineering Graphics, TMH PUBLICATION

v) Narayana K. L. & P. Kannaiah (2008), Text Book on Engineering Drawing, Scitech Publishers.

vi) (Concesponding set of) CAD Software Theory and USER Manuals.

Syllabus for B.E. Semester I Department of Humanities

Course Code : HUT152 **Course : Constitution of India**

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

Course outcome

1. Students will understand the role of constitution in democratic India
2. Students will be responsible students by knowing their fundamental rights and duties
3. Students will develop better understanding of democratic functions of the government of India
4. Students will form better understanding of system of governance for effective participation

Course content

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution of India
3. Salient features and characteristics of the Constitution of India
4. Scheme of the Fundamental Rights
5. The scheme of the Fundamental Duties and its legal status
6. The Directive Principles of State Policy – Its importance and implementation
7. Federal structure and distribution of legislative and financial powers between the Union and the States
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India
9. Union Executive: structure, functions
10. Judiciary: Structure, role with special reference to PIL, writ petitions, strengthening of democracy & social justice
11. Amendment of the Constitutional Powers and Procedure
12. Emergency Provisions: National Emergency, President Rule, Financial Emergency
13. Local Self Government – Constitutional Scheme in India
14. Provisions of civil services: Characteristics, functions, merits and demerits
15. Democratic principles in industry

Book

Durga Das Basu "An Introduction to Constitution of India" 22nd Edition, LexisNexis

Syllabus for B.E. Semester I Department of Physical Education

Course Code : PEP151 **Course : Yoga / Sports**

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

Course outcome

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

1. Understand fundamental skills and basic rules of games offered by the Physical Education Department of RCOEM.
2. Obtained health related physical fitness.
3. Develop body-mind co-ordination through games and yoga.
4. Changed sedentary life styles towards active living.

Brief Objectives of Sports/Yoga Practical Classes:

It has long been proven that a healthy body leads to a healthy mind. With a strong belief in this, Physical Education Department at RCOEM will conduct Sports/Yoga Classes with the objective of maintaining health, fitness and wellness of students as well as create awareness about need for good health and physical fitness. The objective would also be to make the all-round development with team spirit, social values as well as to identify and develop leadership qualities in students through various sports activities. Sports activities would also be conducted with the objective to provide better interaction and recreation to the students which is an important neutralizer for stress. Additionally, the objective would be to evaluate the health related fitness of students so as to recommend and conduct specific Yoga and Sports activities. The emphasis is on participation, with healthy competition.

Programme Outline:

- **Sports**

1. Introduction to sports, offered by the department.
2. Health and safety issues related to sports; knowledge, recognition and ability to deal with injuries and illness associated with sports.
3. Practicing the fundamental skills and bringing awareness of basic rules and regulations.
4. Conduction of small recreational games and activities.

- **Yoga :** Includes various sitting, standing and lying Asanas, Suryanamaskars and Pranayamas.
- **Physical Efficiency Tests :** This includes 6 health related physical fitness tests.

Components	Name of Tests
Speed	50 mts Dash
Agility	Shuttle run
Cardiovascular Endurance	8 mins Run/Walk
Test Flexibility	Sit and Reach Test
Abdominal Strength (M) / shoulder strength (F)	Bent Knee Sit-ups (M)/ Modified Pull-ups (F)
Yogic exercises	Suryanamaskars

Syllabus for B.E. Semester I / II

Course Code : CHT151 **Course : Chemistry**

L: 3 Hrs, T: 1 Hr, P : 0 Hr., Per week **Total Credits : 4**

Course Outcomes

The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10 + 2 levels in schools. Technology is being increasingly based on the electronic, atomic and molecular level modifications. Quantum theory is more than 100 years old and to understand different phenomena; one has to base the description of all chemical processes at molecular levels. The course will enable the student to:

- Explain the differences in the behavior of engineering materials based upon bond type, structure, composition, and processing.
- Analyse microscopic chemistry in terms of atomic and molecular orbitals and to apply this knowledge for understanding the band structure of different types of solids.
- Understand different types of molecular interactions, rationalise bulk properties and processes using thermodynamic considerations.
- Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques
- List major chemical reactions that are used in the synthesis of molecules and to understand structural aspect of organic compounds.
- Analyse impurities present in the water and suggest the methodology for its removal.

Chemistry (Concepts in Chemistry for Engineering)

(1) Engineering Materials (8 Lectures) : Polymeric Materials : Introduction, polymer composites, fibre reinforced composites, Biopolymers (Polylactic acid etc.). Engineering applications of polymers (optical media, data storage, devices, electronics and medical sector).

Nanomaterials : Definition of Nano, Top down bottom up approach, carbon age-new form of carbon (CNT to Graphene), One dimensional, Two dimensional and Three dimensional nanostructured materials, mechanical-physical-chemical, optical properties.Applications of Nanomaterials.

Cement : Raw materials, manufacturing of cement, properties (settling and hardening, heat of hydration, soundness), Types of cement, Rapid hardening, Pozzolonic cement, white cement, High Alumina Cement.

(2) Atomic and molecular structure (8 lectures) : Schroedinger equation. Particle in box solutions, Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Equations for atomic and molecular orbitals. Molecular Orbital Theory and Molecular orbital diagrams of different homo-nuclear and hetero-nuclear diatomic molecules. Pi- molecular orbital diagram of butadiene benzeneand hexatriene.

Crystal field theory and the energy level diagrams for octahedral and tetrahedral complexes of transition metal ions and their magnetic properties.

Band structure of solids and the role of doping on band structures.

(3) Spectroscopic techniques and applications (8 lectures) : Electromagnetic Spectrum, Principles of spectroscopy.

Electronic spectroscopy – Basic Principles, Lambert-Beer's Law, Woodward-Fisher Rule for conjugated dienes.

Fluorescence and its applications in medicine.

Nuclear magnetic resonance – Basic Principles, Chemical Shift, Spectral interpretation of some simple compounds.

(4) Chemical Thermodynamics and Corrosion Science(6 lectures) : Thermodynamic functions: energy, work, entropy, ethalpy and free energy and numerical based on these thermodynamic functions.

Corrosion – Basic principle, mechanism of corrosion, overview of types of corrosion and preventive measures.

(5) Stereo chemistry and Organic Reactions (8 lectures) : Stereoisomers, configurations and symmetry & chirality, enantiomers, diastereomers, optical activity.

Introduction to reactions involving substitution, addition, elimination, oxidation, reduction. Synthesis of a commonly used drug molecule such as Ibuprofen, Aspirin, Paracetamol, Chloroquine/ doxy cycline etc.

(6) Water Technology (6 lectures) : Impurities in natural water, hardness and alkalinity, Disadvantages of hardness i. e. sludge and scale formation, softening of water using lime-soda, zeolite and ion- exchange method, advantages and limitations of these water softening processes, Desalination of water using Reverse Osmosisand electrodialysis.

Suggested Text Books

1. A Textbook of Engineering Chemistry by Dr. Rajshree Khare, S. K. Kataria and Son's Publisher.
2. Selected topics in Inorganic Chemistry by W. U. Malik, R. D. Madan &G. D. Tuli, S. Chand Publications.
3. Engineering Chemistry by A. Pahari, B. Chauhan, Firewall Media, Infinity Science Press LLC.
4. A Textbook of Engineering Chemistry by S. S. Dara, S. Chand Publications.
5. Applied Chemistry by V. K. Walekar, A. V. Bharati, Tech-Max Publications.
6. Organic Chemistry by R. L. Madan, Mc-Graw Hill Publications.
7. Elementary Organic Spectroscopy, Revised Edition by Y. R. Sharma, S. Chand Publications.
8. Organic Chemistry – Reactions and Reagents by O. P. Agrawal, Goel Publishing House Publications.
9. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan

Reference Books

1. Physical Chemistry, by Robert G. Mortimer, Elsevier Academic Press Publications.
2. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane, Mc-Graw Hill Publications.

Syllabus for B.E. Semester I / II

Course Code : CHP151 **Course : Chemistry Lab**

L: 0 Hrs., T: 0 Hrs., P: 3 Hrs., Per week **Total Credits : 1.5**

Laboratory Outcomes

The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering.

The students will learn to:

- Estimate the amount of different impurities in water/waste water samples.
- Estimate rate constants of reactions and order of the reaction from concentration of reactants/products as a function of time and to validate adsorption isotherms.
- Measure molecular/system properties such as surface tension, viscosity of aqueous or other industrially important liquids/mixtures etc.
- Synthesize a polymer or drug molecule or nano-material.

List of Experiments for Chemistry Lab

1. Determination of Surface tension of a given liquid/mixture.
2. Determination of Viscosity of a given liquid/mixture.
3. Estimation of total, temporary and permanent hardness present in a given water sample.
4. Estimation of type and extent of alkalinities present in a given water sample.
5. Estimation of Cu and Zn in a brass sample.
6. Study of chemical oscillations or iodine clock reaction and determination of rate constant of the reaction.
7. Estimation of acid value of oil.
8. Estimation of saponification value of oil.
9. Ion Exchange column for removal of hardness.
10. Study of adsorption of acetic acid by charcoal.
11. Synthesis a polymer / drug molecule / nano-material.

Suggested Books/Reference Books

(1) A Textbook on Experiments and Calculations in Engineering Chemistry by S. S. Dara, S. Chand Publications.

(2) Advanced Practical Physical Chemistry by J. B. Yadav, Krishna's Prakashan Media (P) Limited.

(3) Collection of Interesting General Chemistry Experiments, A by A. J. Elias, Universities Press Publications.

(4) College Practical Chemistry by V. K. Ahluwalia, S. Dhingra and A. Gulati, Universities Press Publications.

(5) Advanced Practical Medicinal Chemistry by Ashutosh Kar, New Age International Publisher.

Syllabus of Group 1 - Semester I and Group 2 - Semester II, Bachelor of Engineering

Course Code: CST151 **Course : Programming for Problem Solving**

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

Course Outcomes

On successful completion of course student will learn:

1. To formulate simple algorithms for arithmetic and logical problems, translate the algorithms to programs (in C language), test and execute the programs and correct syntax and logical errors.
2. To implement conditional branching, iteration and recursion, to decompose a problem into functions and synthesize a complete program using divide and conquer approach.
3. To use arrays, pointers, structures and I/O operations for the formulation of algorithms and programs.
4. To apply programming to solve matrix addition, multiplication problems and searching & sorting problems.

UNIT-I: Introduction to Programming

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.)

Idea of Algorithm : Steps to solve logical and numerical problems. Representation of Algorithm: Flowchart / Pseudocode with examples. Arithmetic expressions and precedence

UNIT-II: C Programming Language

Introduction to C language: Keywords, Constant, Variable, Data types, Operators, Types of Statements, Preprocessor Directives, Decision Control Statement-if, if-else, Nested if-else statement, Switch case, Loops and Writing and evaluation of conditionals and consequent branching.

UNIT-III: Arrays and Basic Algorithms

Arrays: 1-D, 2-D, Character arrays and Strings.

Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

UNIT-IV: Functions and Recursion

User defined and Library Functions, Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference. Recursion: As a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

UNIT-V: Pointers and Structures

Structures, Defining structures, Array of Structures, Introduction to pointers, Defining pointers, Pointer arithmetic, pointer operators, Use of Pointers in self-referential structures, notion of linked list (no implementation) UNIT-VI: File handling

Streams in C, Types of Files, File Input/ Output Operations: Modes of file opening, Reading and writing the file, Closing the files, using fflush().

Text Books

1. Programming in ANSI C : E. Balguruswami McGraw Hill
2. Mastering C: K. R. Venugopal and S. R. Prasad, Tata McGraw Hill

Reference Books

1. Programming with C: Byron Gottfried, Schaums Outline Series.
2. Let Us C: Yashwant Kanetkar, BPB Publication

Syllabus of Group 1 - Semester I and Group 2 - Semester II, Bachelor of Engineering

Course Code: CSP151 **Course : Programming for Problem Solving Lab**

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

Course Outcomes

On successful completion of course student will be able to:

1. Understand the fundamentals of C programming and choose the loops and decision making statements to solve and execute the given problem.
2. Implement different Operations on arrays also design functions to solve the given problem using C programming.
3. Understand pointers, structures, unions and apply them to develop programs.
4. Implement file Operations in C programming for a given application.

CREATIVITY INNOVATION AND DESIGN THINKING COURSE SYLLABUS

Course Code : IDT151 **Credits : 1**

L:1Hrs., T:0Hrs., P:0Hrs., Per week

Course Outcomes

C1: Be familiar with processes and methods of creative problem solving

C2: Enhance their creative and innovative thinking skills

C3: Practice thinking creatively and innovative design and development

Detailed Topics

UNIT I. Introduction: Making a case for creativity, Creative thinking as a skill, Valuing diversity in thinking: Thinking preferences, Creativity styles, Creativity in problem solving

UNIT 2. Pattern Breaking: Thinking differently , Lateral thinking, Mind stimulation: games, brain-twisters and puzzles, Idea-collection processes, Brainstorming/Brainwriting, The SCAMPER methods, Metaphoric thinking, Outrageous thinking , Mapping thoughts, Other (new approaches)

UNIT 3. Using Math and Science, Systematic logical thinking, Using math concepts, Eight-Dimensional (8D) Approach to Ideation: Uniqueness, Dimensionality, Directionality, Consolidation, Segmentation, Modification, Similarity, Experimentation

UNIT4. Systematic Inventive Thinking: Systematic inventive thinking: The TRIZ methodology, Decision and Evaluation: Focused thinking framework, Six thinking hats , Ethical considerations

UNIT 5. Design for Innovation: Introduction to design for interaction, nine lessons for innovation, difference in creativity and innovation, Building blocks for innovation

UNIT 6.Intellectual Property: Introduction to intellectual property: Patents, Copyrights©, Trademarks ®, Trade Secret, Unfair Competition.

Reference Books and Text Book

1. Creative Problem Solving for Managers - Tony Proctor - Routledge Taylor & Francis Group
2. 101 Activities for Teaching creativity and Problem Solving - By Arthur B Vangundy - Pfeiffer
3. H. S. Fogler and S.E. LeBlanc, Strategies for Creative Problem Solving, Prentice Hall
4. E. Lumsdaine and M. Lumsdaine, Creative Problem Solving, McGraw Hill,
5. J. Goldenberg and D. Mazursky, Creativity in product innovation. Cambridge University Press, 2002.

Course Assignments for internal continuous assessment of 20 Marks (NO T1 and T2)

- Brain teasers (aka Puzzle Busters, to be solved individually)
- Cartoon captions (small teams)
- TRIZ, a systematic ideation method, reading (individual)
- Book readings and discussions (small teams)
- Small teams presentations on innovation: (1) innovative individual, (2) innovative company, (3) innovative movie / game, (4) sustainable innovation, (5) innovation in business, (6) innovation in art, (7) innovation in architecture, (8) innovative nation, (9) innovation in science, and (10) innovation in engineering.
- Large groups hands-on projects
- Eight-dimensional (8D) ideation method examples
- Large teams videos

Syllabus Department of Industrial Engineering

Course Code : INT151 **Course : Workshop / Manufacturing Practices (Theory)**

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

Course Outcomes

1. Identify the different manufacturing process commonly employed in Industry along with prevailing safety practices.
2. Identify the various tools and equipments to carry out different manufacturing processes accompanied by the inspection of the work part.

Syllabus

Unit-1 Fundamentals of metal cutting, single point cutting tool, fundamental mechanics of metal cutting, fitting operations, and associated measuring and marking tools

Unit-2 Introduction to pattern making for metal casting, different types of carpentry tools, measuring tools and marking tools, holding devices, different types of carpentry joints.

Unit-3 Smithy and Forging, Forging tools like chisels, hammers, types of furnaces, types of coal, Forming operations, Hot working and Cold working of metals.

Unit-4 Metal joining Process, mechanics of welding, types of welding, soldering and brazing, types of joints Unit-5 Introduction to foundries, Metal Casting, types of sand, Introduction to Molding tools & casting process. Unit-6 Introduction to Plastic Injection Molding

Suggested Text Book

1. "Elements of Workshop Technology" Hajra S.K, Choudhury A. K , Roy Nirjhar Vol. I and Vol .II, Media Promoters and Publishers Private Ltd. Mumbai.

Reference Books

1. Kalpak Jain S. and Schmid S. “Manufacturing Engineering and Technology”4th Edition, Pearson India Education 2008
2. Roy A. and Lindberg, “Process and Materials of Manufacture”4th Edition, Prentice Hall India 1998.

Syllabus Department of Industrial Engineering

Course Code : INP151 **Course : Workshop/Manufacturing Practices Lab (Practical)**

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

Laboratory Outcomes

On the completion of the course the students shall be able to;

1. Recognize the different manufacturing process commonly employed in the Industry
2. Make the components using required manufacturing process, inspection methods while practicing the requisite safety precautions

Contents

1. Fitting Practice
2. Welding and Soldering Practice
3. Pattern Making Practice
4. Metal Casting Practice
5. Smithy and Forging Practice
6. Machining Practice
7. Plastic Molding Process
8. Glass Cutting Process

Suggested Text Book

1. "Elements of Workshop Technology'" Hajra S.K, Choudhury A.K , Roy Nirjhar Vol. I and Vol .II, Media Promoters and Publishers Private Ltd Mumbai.

Reference Books

1. Kalpak Jain S. and Schmid S. "Manufacturing Engineering and Technology"4th Edition, Pearson India Education 2008
2. Roy A. and Lindberg, "Process and Materials of Manufacture", Prentice hall India 1998.

Syllabus for B.E. Semester I / II Dept of Humanities Humanities and Social Sciences

Course Code: HUT151 **Course : English**

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

Course Objectives

The main objective of the subject is to enhance the employability skills of engineering students as well as communication skills at work place. The sub-objectives are:

1. To develop vocabulary of students.
2. To orient students in basic writing skills.
3. To orient students in functional grammar.
4. To orient students in the process of effective writing.
5. To provide practice and improve students' oral communication skills.

Course Outcomes

1. Students will have good word power.
2. Students will acquire basic writing skills.
3. Students will understand functional grammar and its usage.
4. Students will organize and express their thoughts effectively through written communication.
5. Students will learn oral communication skills in order to handle themselves effectively in an interview and group discussion

Syllabus

1. Vocabulary Building

1.1. The concept of Word Formation

1.2. Root words from foreign languages and their use in English

1.3. Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives

1.4. Synonyms, Antonyms and standard abbreviations

2. Basic Writing Skills

2.1 Sentence Structures

2.2 Use of phrases and clauses in sentences

2.3 Importance of proper punctuation

2.4 Creating coherence

2.5 Organizing principles of paragraphs in documents

2.6 Techniques for writing precisely

3. Identifying Common Errors in Writing

3.1 Subject-verb agreement

3.2 Noun-pronoun agreement

4. Misplaced modifiers

3.1 Articles

3.2 Redundancies

3.3 Cliches

1. Nature and Style of sensible Writing

4.1 Describing

4.2 Defining

4.3 Classifying

4.4 Providing examples or evidence

2. Writing Practices

5.1 Comprehension

5.2 Precis Writing

5.3 Essay Writing

5.4 Letter Writing

5.5 Email Writing

3. Oral Communication

(This unit involves interactive practice sessions in Language Lab)

- Listening Comprehension
- Pronunciation, Intonation, Stress and Rhythm
- Common Everyday Situations : Conversations and Dialogues
- Communication at Workplace
- Interviews
- Formal Presentations

Books

1. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
2. Practical English Usage. Michael Swan. OUP. 1995.
3. Remedial English Grammar. F.T. Wood. Macmillan.2007
4. On Writing Well. William Zinsser. Harper Resource Book. 2001
5. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
6. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

Syllabus for B.E. Semester I
Humanities

Course Code: HUP151 **Course : English Lab**

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

Course objective

1. To enhance competency of communication in English among learners.

Course outcomes

1. Students learn presentation and public speaking skills
2. Students learn to practice effective strategies for Personal Interview and Group Discussions
3. Students learn and effectively apply language skills – listening, speaking, reading and writing

List of Practical

1. Common Everyday Situations: Conversations and Dialogues
2. Pronunciation, Intonation , Stress, and Rhythm
3. Formal Presentations: Orientation
4. Formal Presentations : Practice Session
5. Interviews: Orientation
6. Interviews: Practice Session
7. Communication at Workplace: Group Discussion- Orientation
8. Communication at Workplace: Practice Session

III Semester
Department of Electrical Engineering

Course Code : MAT256 **Course : Electrical Engineering Mathematics**

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

Course Outcomes

After studying the course, the students will be able to: 1.Understand Laplace transforms to solve engineering problems. 2.Understand the complex variables and its application.

3. Solve field problems in engineering involving PDEs.
4. Apply statistical method for analyzing experimental data and understand the basic importance of Numerical Methods to solve problems related to Engineering applications.

MODULE 1: [10Hours]

Laplace Transforms: Laplace transforms and their properties, Application for Laplace Transform to solve ordinary differential equations including simultaneous Differential Equations. Solution of one dimensional Partial differential equations by Laplace Transform method.

MODULE 2: [8Hours]

Functions of a Complex Variable: Function of a complex variable, Analytic functions, Cauchy-Riemann conditions, Conjugate functions, singularities, Cauchy's integral theorem and integral formula, Taylor's and Laurent's theorem, Residue theorem.

MODULE 3: [8Hours]

Partial Differential equations: Partial differential equation of first order first degree i.e. Lagrange's form. Linear homogeneous PDE of nth order with constant coefficient, method of separation of variables, Applications of partial differential equations.

MODULE 4: [8Hours]

Numerical Methods: Solution of algebraic and transcendental equations using method of false position and Newton-Raphson method. Solution of system of linear equations, Gauss elimination method, Gauss- Seidal method, .

Numerical solution of ordinary differential equations by Taylor's series method, Modified Euler's method, Runge-Kutta method.

MODULE 5: [8Hours]

Random Variable and Probability distribution: Expectation of Discrete Random Variables, Moments, Variance of Sum, Continuous random variables and their properties, Probability density function, probability distribution function for Discrete and continuous random variables, normal, exponential distribution.

Textbooks/References

1. S.S.Sastry, Introductory methods of numerical analysis, PHI,4th Edition,2005.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
5. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.

III Semester
Department of Electrical Engineering

Course Code : CET271 **Course : Engineering Mechanics and Strength of Materials**

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

MODULE 1: [06 Hours]

Introduction to Engineering Mechanics: Force Systems, Basic concepts, System of Forces, Coplanar

Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Introduction to vectors and tensors and coordinate systems; Vector and tensor algebra.

MODULE 2: [08 Hours]

Equilibrium & Friction: Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Virtual displacements, principle of virtual work for particle and system of rigid bodies, Analysis of truss using different methods. Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack; simple lifting machines.

MODULE 3: [06 Hours]

Centroid and Moment of Inertia: Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections.

MODULE 4: [06 Hours]

Mechanical Vibration: Classification of vibration, damping and vibration, features of vibrating system, free vibration without damping, free vibration with damping, forced vibration without damping, forced vibration with damping, pendulum motion.

MODULE 5: [06 Hours]

Particle dynamics: Kinematics and Kinetics of particles, rectilinear motion, curvilinear motion, D'Alemberts principle and its application in connected system of particles, Impulse Momentum, Collision of bodies, Work Energy Method.

MODULE 6: [08 Hours]

Bending Moment & Shear Force: Transverse loading on beams, shear force and bending moment in beams, analysis of Cantilevers, simply supported beams and overhanging beams, relationships between loadings, shear force and bending moment, shear force and bending moment diagrams.

Torsional Motion: Torsion of circular shafts, derivation of torsion equation, stress and deformation in circular and hollow shafts.

Text Books

1. Engineering Mechanics : F.L.Singer (Harper & Row Publication)
2. Fundamentals of Engineering Mechanics: A.K.Sharma, Sai Publication
3. Engineering Mechanics: Basudeb Bhattacharya,(Oxford University Press)
4. Strength of material : F.L.Singer , Harper & Row, New york
5. Strength of Materials : R. K.Rajput, S Chand

Reference Books

1. Engineering Mechanics: Timoshenko & Young, Tata McGraw Hill
2. Engineering Mechanics: Bear Johnston, Tata McGraw Hill
3. Engineering Mechanics: I.H.Shames, Phi Pvt. Ltd.
4. Mechanics of Materials "Beer,Johnston, Dewolf, Tata McGra Hill

III Semester
Department of Electrical Engineering

Course Code : EET251 **Course : Network Analysis**

L: 3 Hrs., T: 1 Hrs., P: 0 Hrs., Per week **Total Credits : 04**

Course Outcomes

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

CO1: Students can apply the basic Mathematical tools to circuit analysis.

CO2: Students can apply the frequency analysis to circuit with different input signals.

CO3: Students can find the useful characteristics of networks &three phase power.

CO4: Students can apply the graphical approach to networks.

Module-1 :Nodal And Mesh Basis Equilibrium Equations: [8 Hours]

Matrix approach for complicated network, containing voltage, current sources and reactances, source transformations, Solutions of Mutually coupled Networks, Duality.

Module-2: Network Theorems: [8 Hours]

Superposition, Reciprocity, Thevenin's, Norton's. Maximum Power Transfer, Compensation, Tellegen's theorem as applied to DC & A. C. circuits.

Module-3:Laplace Transform & Properties: [7 Hours]

Partial fractions, Evaluation of initial condition, Singularity functions, Waveforms synthesis, Steady state and transient state analysis of RL, RC, RLC network with and without initial conditions with Laplace transforms.

Module- 4: Network Functions & Sinusoidal Steady State Analysis:[7 Hours]

Transient behavior, Concept of complex frequency, Driving points and transfer functions, Poles, Zeros of admittance function, Their properties, Sinusoidal response from Pole- Zero locations, convolution integral solution. The Sinusoid &it's significance, Sine function with rotating phasor, phasor diagrams.

Module-5: Two Port Networks: [6 Hours]

Network parameters and inter-connections, Three phase unbalanced circuit and power calculations. Resonance in series & parallel RL, RC RLC circuits.

Module6-Network Graph Theory:[6 Hours]

Paths and Cycles, Connectivity, Trees, Spanning Subgraphs, Hamiltonian and Euler cycles. Matching theory. Planar graphs. Flows in networks, the max-flow min-cut theorem. Random graphs. Formation of incidence Matrix, Cut-set Matrix, Tie-set Matrix, Structural properties of large graphs

Text / References

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
2. D. Roy Choudhury, "Networks and Systems", New Age International Publications,1998.
3. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.
4. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education,2004.
5. A.Chakrabarty, "Circuit Theory (Analysis & Synthesis)", Dhanpat Rai & Co. 2006

References

1. Allan H. Robbins, Wilhelm C. Miller, "Circuit Analysis Theory and Practice", Cengage Learning India, 2013.
2. Jegatheesan, R., "Analysis of Electric Circuits," McGraw Hill, 2015.
3. Joseph A. Edminister, Mahmood Nahri, "Electric circuits", Schaum's series, McGraw- Hill, New Delhi, 2010.
4. M E Van Valkenburg, "Network Analysis",Prentice-Hall of India Pvt Ltd, New Delhi,2015.
5. Mahadevan, K., Chitra, C., "Electric Circuits Analysis," Prentice-Hall of India Pvt Ltd., New Delhi, 2015.
6. Richard C. Dorf and James A. Svoboda, "Introduction to Electric Circuits", 7th Edition, John Wiley & Sons, Inc. 2015.
7. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", McGraw Hill, 2015.

III Semester

Department of Electrical Engineering

Course Code : ENT259 **Course : Analog Electronic Circuits**

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

Course Outcomes

At the end of this course, students will demonstrate the ability to

CO 1: Understand the operation and analyze the characteristics of semiconductor diodes, MOSFET, and BJT.

CO 2: Examine and design electronic circuits containing non-linear elements such as diodes, MOSFET, & BJT using the concepts of biasing, load lines, operating point and incremental analysis.

CO 3: Apply feedback techniques in amplifier and examine its effect on parameters of amplifiers (ex. Gain, bandwidth, i/p and o/p impedance, etc) and the stability of amplifier.

CO 4: Understand the functioning of OP-AMP and design OP-AMP based circuits for linear and nonlinear applications.

MODULE 1: [04 Hours]

Diode Circuits: P-N junction diode, V-I characteristics of a diode; half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuit.

MODULE 2: [08 Hours]

BJT Circuits: Structure and V-I characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, biasing circuits; common-emitter, common-base and common-collector amplifiers; Small signal equivalent circuit, high-frequency equivalent circuits.

MODULE 3: [08 Hours]

MOSFET Circuits: MOSFET structure and V-I characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuit - gain, input and output impedances, trans-conductance, high frequency equivalent circuit.

MODULE 4: [07 Hours]

Feedback amplifier & Stability: General Feedback amplifier Structure, Properties of Negative Feedback, Basic Feedback Topologies, The Stability of Amplifier, Transfer Function of the feedback Amplifier, Poles and Zeros of Amplifier Transfer Function, Effect of Feedback on the amplifier poles, phase margin, unity gain bandwidth

MODULE 5: [07 Hours]

Operational amplifier: Ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, Gain bandwidth product) Op-amp circuits: Inverting and non-inverting amplifier, differential amplifier.

MODULE 6: [08 Hours]

Linear and Nonlinear applications of op-amp: Instrumentation amplifier, integrator, differentiator, active filter, oscillators (Wein bridge and phase shift). A/D, D/A Converters, Comparator, Square-wave and triangular-wave generators. Precision rectifier, Logarithmic amplifiers; Multivibrators

Textbook

1. Adel S. Sedra, Kenneth C. Smith, Arun N. Chandorkar, "Microelectronics Circuits: Theory and Applications," Seventh Edition, Oxford University Press, 2017.
2. Sergio Franco,"Design with Operational Amplifiers and Analog Integrated Circuits," Fourth Edition, McGraw-Hill Education, 2014.

Reference books

1. Donald Neamen, "Electronic Circuits: Analysis and Design," Third Edition, McGraw-Hill Publication, 2006.
2. Donald Neamen, "Semiconductor Physics and Devices: Basic Principles," Fourth edition, McGraw-Hill, 2011.
3. Jacob Millman, Christos Halkias, Chetan Parikh, "Millman's Integrated Electronics," Second edition, McGraw Hill Education, 2017.
4. J. V. Wait, L.P. Huelsman and G. A. Korn, Introduction to Operational Amplifier theory and applications, 2nd Edition, McGraw Hill, New York, 1992.
5. P. R. Gray, R. G. Meyer and S. Lewis, "Analysis and Design of Analog Integrated Circuits", John Wiley & Sons, 2001.

III Semester

Department of Electrical Engineering

Course Code : EET252 **Course : Electrical Measurements and Instrumentation**

L: 2 Hrs., T: 1 Hrs., P: 0 Hrs., Per week **Total Credits : 03**

Course Objective

1. To introduce the basic principles of all measuring instruments.
2. To deal with the measurement of voltage, current, Power factor, power, energy and measurement of non electrical quantity such as pressure, temperature, flow, and motion.

Course Outcomes

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

1. Understand different types of measuring instruments, their construction, operation and characteristics.
2. Identify the instruments suitable for typical measurements.
3. Apply the knowledge about transducers and instrument transformers to use them effectively.

Module -1: Philosophy of Measurement and Measurement of basic electrical elements :

Measurement System, classification of different measuring Instruments, loading effect of instruments. Methods of measuring resistances, D. C. bridge (Wheat stone, Kelvin and Kelvin's Double bridge) A.C. bridges (Schering Bridge, Maxwell, and Schering bridges), Potentiometers.

Module - 2 : Analog Measurement Techniques :

Principles of permanent magnet moving coil (PMMC), moving iron (MI) and dynamometer type instruments, extension of range of meters. Measurement of power with dynamometer instruments.

Module 3: Digital Measurement Techniques :

True RMS measurement, measurement of voltage, Current, power, frequency and energy.

Module - 4 : Special Instruments :

Megger, Ohm-meter, Earth tester, instrument transformers, applicaitons of instrument transformers.

Module - 5 : Instrumentation :

Study of different types of transducers. Applications of transducers for measurement of motion, pressure, flow and temperature.

Text books

1. A Course in Electrical and Electronics Measurements and Instrumentation : 11 ed., Sawhaney A.K., Dhanpat Rai & Sons, Delhi 1994.
2. Electrical Measurements and Measuring Instruments : 3ed., Golding, E. W., Widdis, F. C., Wheeler's Student Edition, 1994.
3. Electrical Measurements and Instrumentation : U. A. Bakshi, A. V. Bakshi, Technical Publicaitons, 2009.
4. Electrical and Electronic Measurements and Instrumentation : R. K. Rajput.

Reference Book :

1. Electronic Measurements and Instrumentation: 3 ed., Cooper, W.D., Helfrick, A.D., Prentice-Hall of India,New Delhi 1991.

III Semester
Department of Electrical Engineering

Course Code : HUT251 **Course : Principles of Economics and Management**

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

Course Outcome

CO1: Students will be acquainted with the basic concepts of Economics

CO2: Students will understand concepts that are the basis of the working of an economy.

CO3: Students will understand application of Economics in society and environment.

CO4: Students will understand the basics of management.

CO5: Students will be acquainted with the importance and application of Human Resource Management concepts

CO6: Students will learn about financial management and its areas of application.

MODULE 1: [7 Hours]

Micro Economics: Introduction to Economics: Definitions and scope, nature, methods, Central Economic Problems, Theory of Demand and Supply: Law of Demand and supply, its determinants, exceptions, and elasticity, Types of Market and industry equilibrium.

MODULE 2: [9 Hours]

Macro Economics: Different types of economy (Capitalist, Socialist, Mixed), Introduction to Indian Economy, National Income in India: Basic Concepts- GDP, GNP, NDP, NNP, FID, NFIA, per capita Income, Banks: Central Banks (Function and Credit control) Commercial Bank (Functions and credit creation), NBFSs, Inflation, Phrases of Business cycle, Taxation (Direct, Indirect/GST),

MODULE 3: [9 Hours]

Economic Sociology and Environmental Economics: Sociology of labour markets: Sociological approaches (Classical and Neoclassical theory) to labour markets; Social determinants of inequalities in wage and earning. Social cultural aspects of economic development: Impact of religion, caste, gender, ethnicity, family on economy. Environmental economics: Concept of sustainable development, methods of environmental evaluation: cost and benefit analysis, Hedonic pricing, willingness to pay (Consumer surplus).

MODULE 4: [6 Hours]

Introduction to Management: Definition of management, difference between management and administration, evolution of management, functions of management, functions of management: planning (PESTLE model), direction, controlling.

MODULE 5: [6 Hours]

Human Resource Management: The role of Human resources: Definition, Skill needed for HRM, today's HRM Challenges, Diversity and multiculturalism, recruitment and selection, training and development, compensation and benefits, managing employees' performance, employee assessment, work stress, safety and health

MODULE 6: [4 Hours]

Financial Management: Introduction to Financial Management: Definition, Objectives, Role of financial management in contemporary scenario, Financial Statements and tools: balance sheet, profit and loss account, budget, ratio analysis, depreciation.

Text Books

1. KK Dewett, Modern Economic Theory, (43rd Edition), S. Chand and Co. Ltd, New Delhi
2. P.C. Tripathi and P.N. Reddy "Principles of Management", Tata MacGraw Hill Publishing Co. Ltd. New Delhi
3. K. Aswathaptha "Human Resource Management" Tata MacGraw Hill Publishing Co. Ltd. , New Delhi
4. Ravi M. Kishore "Financial Management" Taxman Allied Services (P) Ltd., New Delhi
5. Fevre, Ralph. (1992), The Sociology of Labour Markets. Harvester Wheatsheaf, the University of California.
6. Rabindra N. Bhattacharya (2002) "Environmental Economics: An Indian Perspective", Oxford University Press
7. Karpagam M. (2012) "Environmental Economics", Sterling Publishers ltd

Reference books

1. M.L. Jhingan (2016) "Micro Economics", 8th Edition, 2016
2. M.L. Jhingan (2016) "MacroEconomic Theory", 13th Edition, 2016
3. K.K. Dewett and J.D. Varma "Elementary Economic Theory", S. Chand and Co, New Delhi
4. Rudradutt, K.P.M. Sundaram "Indian Economy", S. Chand and Co. Ltd
5. Martang. S. Telang "Industrial and Business Management", S. Chand and Co. Ltd, New Delhi
6. T. Ramaswamy, "Principles of Management" Himalaya Publishing House, Mumbai

III Semester

Department of Electrical Engineering

Course Code : CHT251 **Course : Environmental Science**

L: 2 Hrs., T: 0 Hrs., P: 0 Hrs., Per week **Total Credits : 02**

Course Outcomes

On successful completion of the course, the students:

1. Will get sufficient knowledge regarding different types of environmental pollutions, their causes, detrimental effects on environment and effective control measures.
2. Will realize the need to change an individual'soutlook, so as to perceive our environmental issues correctly, using practical approach based on observations and self learning.
3. Will become conversant with recent waste management techniques such as E-wastes, its recycling and management.
4. Will gain knowledge about the modes for sustainable development, importance of green energy and processes.
5. Will be able to identify and analyze environmental problems as well as risks associated with these problems and greener efforts to be adopted, to protect the environment from getting polluted.

Syllabus

Principle of contaminant behaviour and recent trends in environmental pollution control

I- Air pollution and its control techniques:(4 lectures)

Contaminant behaviour in the environment, Air pollution due to SOx, NOx, photochemical smog, Indoor air pollution.

Natural pathways for degradation:Carbon cycle, Sulphur cycle, Nitrogen cycle, Oxygen cycle.

Factors responsible for altering the composition of atmosphere (deforestation, burning of fossil fuels, industrial and vehicular emissions, CFCs).

Techniques to control Air pollution, ambient air quality and continuous air quality monitoring, Control measures at source, Kyoto Protocol, Carbon Credits.

II- Noise pollution and its control techniques: (2 lectures)

Introduction to noise pollution and its causes

Noise pollution control: Recent advances in noise pollution control and benefits.

III- Soil pollution and its control techniques: (5 lectures)

Soil pollution: Soil around us, Soil water characteristics, soil pollution.

Solid waste management: Composting, vermiculture, landfills, hazardous waste treatment, bioremediation technologies, conventional techniques (land farming, constructed wetlands), and phytoremediation.

Degradation of xenobiotics in environment: Petroleum hydrocarbons, pesticides, heavy metals

IV- Water pollution and its control techniques: (8 lectures)

Major sources of water pollution:Eutrophication, acid mine drains, pesticides and fertilizers, dyeing and tanning, marine pollution, microplastics

Techniques to control water pollution: Conventional waste water treatment-types of sewage, sewerage system, alternative systems, primary, secondary and tertiary processes including aerobic and anaerobic techniques, safe disposal.

Case studies

Treatment schemes for waste water from dairy, textile, power plants, pharmaceutical industries, and agro based industries such as rice mills

V- E-wastes (2 lectures)

Introduction, types of e-wastes, environmental impact, e-waste recycling, e-waste management rules.

VI- Environmental Sustainability: Role of Green technology (5 lectures)

Concept of green technologies, categories, goals and significance, sustainability

Green energy, green chemistry, challenges to green technology, advantage and disadvantages of green processes, Eco mark certification- its importance and implementation

VII- Different government initiatives (2 lectures)

National ambient air quality standard 2009, Swacch bharat abhiyan, National afforestation program and Act- 2016, National river conservation plan, Formation of National Green Tribunal

Books Suggested

1) Benny Joseph, Environmental Studies, Mc Graw Hill Education (India) Private Limited

2) B. K. Sharma, Environmental Chemistry, Goel Publishing House, Meerut

3) PAarneVesilind, J. Jeffrey Peirce and Ruth F. Weiner, Environmental Pollution and Control, Butterworth -Heinemann

4) D. D. Mishra, S. S. Dara,A Textbook of Environmental Chemistry and Pollution Control, S. Chand & Company Ltd. Sultan Chand & Company

5) Shree Nath Singh, Microbial Degradation of Xenobiotics, Springer-Verlag Berlin Heidelberg

6) P.T. Anastas& J.C. Warner, Green Chemistry: Theory & practice, Oxford University Press

7) P.Thangavel & Sridevi, Environemental Sustainability: Role of Green technologies, Springer publications

IV Semester
Department of Electrical Engineering

Course Code : ENT260 **Course : Digital Electronics and Microprocessor**

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

Course Outcomes

At the end of this course, students will demonstrate the ability to

CO1: Design different combinational circuits for various applications.

CO2: Design various sequential circuits for different applications.

CO3: Design and verify digital systems using combinational and sequential circuits.

CO4: Understand the architecture of 8085 microprocessor and it's working.

CO5: Develop assembly language program using 8085 microprocessor instruction set.

CO6: Understand the concept of Subroutines and Interrupts in 8085 microprocessor.

MODULE 1: [06 Hours]

Logic Simplification: Binary/Hexa/octal/BCD Number system, Binary Arithmetic, Boolean Algebra and De Morgan's Theorem, Logic Gates, SOP & POS forms, Logic Optimization Technique, Karnaugh maps. Introduction to logic families, TTL and CMOS logic, Tri-state logic, Memory-classification, organization, operation and interfacing.

MODULE 2: [06 Hours]

Combinational logic Design: Comparators, Multiplexers, Demultiplexer, Encoder, Decoder, Arithmetic Circuit Design, Barrel Shifter, ALU.

MODULE 3: [09 Lectures]

Sequential Logic DesignLatches, Flip flop – S-R, J-K, D, T and Master-Slave JK FF, counters, Shift registers.

MODULE 4: [06 Hours]

Microprocessor Introduction: Introduction of Intel's 8085A: Architecture, description. Flag structure, concept of PSW, Addressing modes, Timing diagrams,

MODULE 5: [09 Hours]

Programming: Instruction Set Stack and Subroutine, Simple and Nested subroutines, Push-Pop, Call-Return instructions, Stack manipulation, (simple programming)..

MODULE 6: [06 Hours]

Interrupts: Interrupt concept& structure in 8085, Interrupt Service Routines (ISR), advanced instructions of Programming of 8085A.

Text books

1. Digital Electronic Principles, By Malvino PHI, 3rd Edition.
2. Modern Digital Electronics, R. P. Jain, McGraw Hill Education, 2009.
3. Microprocessor, Architecture, Programming and Applications with 8085, Ramesh S.Gaonkar, 5th Edition, Penram International Publications.

Reference books

1. Digital logic and Computer design, M. M. Mano, Pearson Education India, 2016.
2. Fundamentals of Digital Circuits, A. Kumar, Prentice Hall India, 2016.

IV Semester
Department of Electrical Engineering

Course Code : EET271 **Course : Signals and Systems**

L: 2 Hrs., T: 1 Hrs., P: 0 Hrs., Per week **Total Credits : 03**

Course Outcomes

At the end of this course, students will demonstrate the ability to

CO1: Understand the different types of signals and systems.

CO2: Understand the concepts of continuous time and discrete time systems.

CO3: Analyze systems in complex frequency domain.

CO4: Understand sampling theorem and its implications.

Module 1: Introduction to Signals and Systems (7 hours):

Signals and systems as seen in everyday life, and in various branches of engineering and science. Different types and properties of signal and systems. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals.

Module 2: Behavior of continuous and discrete-time LTI systems (7 hours)

Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response

Module 3: Fourier Transform (5 hours)

Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT), the Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT). Parseval's Theorem.

Module 4: Laplace Transform (5 hours)

Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior.

Module 5: z- Transform (5 hours)

The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.

Module 6: Sampling and Reconstruction (6 hours)

The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

Text/References

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals and systems", Prentice Hall India, 1997.
2. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", Pearson, 2006.
3. H. P. Hsu, "Signals and systems", Schaum's series, McGraw Hill Education, 2010.
4. S. Haykin and B. V. Veen, "Signals and Systems", John Wiley and Sons, 2007.AICTE Model Curriculum for Undergraduate degree in Electrical Engineering (Engineering & Technology)
5. A. V. Oppenheim and R. W. Schafer, "Discrete-Time Signal Processing", Prentice Hall, 2009.
6. M. J. Robert "Fundamentals of Signals and Systems", McGraw Hill Education, 2007.
7. B. P. Lathi, "Linear Systems and Signals", Oxford University Press, 2009.

IV Semester
Department of Electrical Engineering

Course Code : EET272 **Course : Electrical Machines-I**

L: 3 Hrs., T: 1 Hrs., P: 0 Hrs., Per week **Total Credits : 04**

Course Outcomes

Upon the completion of this course students will be able to understand:

CO1: Basic principles, constructional features, electric and magnetic circuits of various electrical machines.

CO2: Construction and operation characteristics of DC motor and DC generator.

CO3: Constructional features and operation of single phase and three phase transformer and determine equivalent circuit parameters, efficiency and regulation at different loads.

CO4: Various transformer connection, phasor groups, parallel operation and concept of daily load cycle to calculate all day efficiency.

CO5: Construction operation and characteristics of three phase induction motors, and its testing to calculate equivalent circuit parameters.

CO6: Starting, speed control and power stages of three phase induction motor and construction and principle of single phase induction motors.

MODULE 1:

Basic Concepts and Magnetic Circuit (08 Hours)

MMF and reluctance, Faraday's Law, Dynamically and statically induced EMF, Self, mutual and leakage inductance, Electric and magnetic circuits for various electrical machines (Cores and windings). B-H Curve, Magnetic losses and it's dependence on voltage and frequency.

MODULE 2:

D. C. Machines (08 Hours)

Basic principle & operation of DC generators and DC motors (separately excited, shunt and series), Induced emf equation, Characteristics of DC generators and DC motors, speed control of DC motors, Losses & Efficiency.

MODULE 3:

1 Phase & 3 Phase Transformer : Construction & Pricniple (08 Hours)

Transformer operation and principle, phasor, equations and phasor diagrams at different p.f., O.C. & S.C. test, determination of equivalent circuit parameters, regulation, efficiency, Auto transformer, Concept of Inrush current.

MODULE 4:

1 Phase & 3 Phase Transformer : Operation & Testing (08 Hours)

Daily Load Cycle and All day efficiency of transformer, Polarity test, various connections with vector groups, Three phase to two phase conversion (qualitative analysis), parallel operation of transformer, methods of cooling, temperature rise test. Tap changer (on load and off load).

MODULE 5:

Three Phase Induction Motor: Construction and Principle (08 Hours)

Types of induction motor and production of torque, Torque-slip characteristics (Induction Motor and Generator), No load blocked rotor test, equivalent circuit & determination of equivalent circuit parameters, losses, efficiency.

MODULE 6:

Operation of Single phase and Three Phase Induction Motor (08 Hours)

Power stages of induction motor, losses and efficiency, Load characteristics of induction motor, Starting and Speed control of induction motor. Double cage motors, Single phase induction motor (Split phase and shaded pole).A. C. Series motor.

Text Books

1. Electrical Machines: Dr. P.S. Bimbhra
2. Electrical Machines: Ashfaq Hussain
3. A Text Book of Electrical Technology: B. L. Theraja (Vol. II)

Reference Books

1. Performance & Design of A.C. Machine: M. G. Say
2. Electrical Machines: I.S. Nagrath& Dr. D.P. Kothari
3. Laboratory Courses in Electrical Engineering: S. G. Tarnekar, Kharbanda, S. B. Bodkhe & S. D. Naik

IV Semester
Department of Electrical Engineering

Course Code : EET273 **Course : Programming for EE Applications**

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

Course Objectives

1. To design the applications using C language or object oriented programming language like C++ or by using Python.
2. To solve electrical application using object oriented techniques.

Course Outcomes

On completion of the course students should be able to :

CO 1 : Develop programs on building of Functions, Arrays, Pointers and Structure for solving engineering problems.

CO 2 : Design programs using a variety of data structures such as stacks, queues, hash tables, binary trees and implement sorting algorithm.

CO 3 : Understand and apply the features of object oriented programming concepts.

CO 4 : Apply the concept of operator overloading, inheritance and polymorphism in problem solving.

CO 5 : Execute programs using basic features of Python language and work with external Python libraries.

Module 1 : Applications of C Concepts : (06 Hrs)

Pointers to Function, Pointers to Structures, accessing members of structures using structure variables, passing structures to functions. Structures as user defined data types, File handling. Programs based on solving Engineering problems.

Module 2 : Data Structures in C : (08 Hrs)

Introduction to Data Structures : Basic Concepts of Data, Types of Data Structures, Arrays : Quick Sort, Merge Sort, Heap Sort, selection and bubble sort. Programs based on solving Engineering problems.

Module 3 : Data Structure Applications : (06 Hrs)

Definition and applications of Stacks. Queues, Linked Lists and Trees. Introductions to Hashing tables.

Module 4 : Introduction to Object Oriented Programming (C++) : (06 Hrs)

Concept of object, class, objects as variables of class data type, difference in structures and class in terms of access to members, private and public. Structure of C++ programs, introduction to defining

member functions within and outside a class, declaring class, creating objects, constructors & destructor functions. Members of a class, data & function members.

Module 5 : Object Oriented Programming Applications : (08 Hrs)

Operator Overloading : Fundamentals, Restrictions, operator functions as class members v/s as friend functions. Inheritance : Base classes and derived classes, protected members, relationship between base class and derived classes, constructors and destructors in derived classes, public, private and protected inheritance Polymorphism : concept, relationship among objects in inheritance hierarchy, abstract classes, and polymorphism. Programs based on solving Engineering problems.

Module 6 : Introduction to Python Programming : (08 Hrs)

Types, Values, Expressions using if, else and while. Implementing functions, lists, tupples and dictionaries. Import and use of Python libraries like. Numpy and Matplotlib for developing applications.

Text Books

1. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
2. "Fundamentals of Data Structures", Illustrated Edition by Ellis Horowitz, Sartaj Sahni, Computer Science Press.
3. Programming in C + + : E. Balguruswami,
4. Python essential reference, 3rd Edition - David M. Beazley.

Reference books

1. “Algorithms, Data Structures, and Problem Solving with C + + ”, Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company.
2. Think Python, 2nd Edition - How to Think like a Computer Scientist Allen B. Downey

IV Semester

Department of Electrical Engineering

Course Code : EET299-1 **Course : Consumer Electrical Appliances**

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

Course Outcomes

Upon completion of this course, students will be able to.

CO1: Understand concept of Energy Efficiency of Electrical appliances & types of power supply unit used in these appliances.

CO2: Understand the different electrical power supply backup equipments like battery, Inverter, UPS, & photovoltaic system.

CO3: Understand working principle & application of different electrical motors.

CO4: Understand working principle of appliances used for heating & cooling purpose. CO5: Understand construction & working principle of electrical domestic appliances. CO6: Test & perform maintenance of Consumer Electrical Appliances.

MODULE 1: [06 Hours]

Basics of DC & AC systems, voltage-current-power relationships, AC DC sources for appliances, Star rating, Energy efficiency in Electrical appliances, Importance of IS codes, IE codes

MODULE 2: [08 Hours]

Introduction to AC/DC Motors for Appliances (FHP Motors) - Single Phase Motors (FHP), DC Motors, BLDC Motors, Universal Motors.

MODULE 3: [08 Hours]

HVAC Appliances-: Construction, Working Principle, Ratings/Specifications, Control of

a) Resistance heating: Water heaters, Room Heater, Tea/ Coffee Maker, Oven, Toasters, Iron

b) Non Resistive heating: Induction heaters, Microwave oven

c) Cooling Appliances: Construction, Working Principle, Ratings/Specifications, Control of Fans, Desert Coolers, Air conditioner, Refrigerator

MODULE 4: 08 Hours]

Power supply Equipment: Battery and battery chargers, Switch mode power supply, Inverter, Uninterrupted Power Supply (UPS), Photovoltaic power System

MODULE 5: [06Hours]

Other Consumer appliances: Construction, Working Principle, Ratings/Specifications, Control Mixer, Grinder, Juicer, Vacuum Cleaner, Air Purifier, Washing Machines, Weighing scale, Elevator

MODULE 6: [06 Hours]

Illumination-Construction, Working Principle, Ratings/Specifications, Control of LED Lights.

Text Book/ Resources:

1) Consumer Electronics by S P Bali, Pearson

2) Handbook of Repair & Maintenance of domestic electronics appliances: BPB Publications

3) Literature available through e-resources

IV Semester
Department of Electrical Engineering

Course Code : EET299-2 **Course : Renewable Energy Systems**

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

Course Outcomes

Understanding of renewable energy sources

Knowledge of working principle of various energy systems Capability to carry out basic design of renewable energy systems

MODULE-I : (05 Hrs)

Global and National Energy Scenario: Over view of conventional & renewable energy sources, need, potential &development of renewable energy sources, types of renewable energy systems, Future of Energy Use, Global and Indian Energy scenario, Energy for sustainable development, renewable electricity and key elements, Global climate change, CO2 reduction potential of renewable energy-concept of Hybrid systems.

MODULE–II: (10 Hrs)

Solar Energy: Solar energy system, Solar Radiation, Availability, Measurement and Estimation, Solar Thermal Conversion Devices and Storage, Solar-Electrical Power Generation, general Solar Photo Voltaic (SVP) system, Different configurations, SPV system components and their characteristics, Stand-Alone and Grid Connected SPV systems, other Miscellaneous Applications of Solar Energy.

MODULE–III: (06 Hrs)

Wind Energy: Wind Energy Conversion, Potential, Nature of the wind, Wind Data and Energy Estimation, Site selection, Types of wind turbines, Wind farms, Wind Generation and Control., classification of wind, characteristics, offshore wind energy – Hybrid systems, wind energy potential and installation in India.

MODULE -IV: (06 Hrs)

Hydel and Tidal Power Systems: Basic working principle, Classification of hydel systems: Large, small, micro–measurement of head and flow – Energy equation – Types of turbines – Numerical problems. Tidal power – Basics – Kinetic energy equation – Numerical problems – Wave power – Basics – Kinetic energy equation.

MODULE- V: (06 Hrs)

Bio-Mass,Geothermal& Ocean Energy: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C. Engine operation and economic aspects.

Geothermal Energy: Resources, types of wells, methods of harnessing the energy, potential in India. Ocean Energy:OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles.

MODULE- VI: (05 Hrs)

Integrated Energy Systems: Introduction, Integrated Smart infrastructure, Integrated Energy system Modeling, Various Integrated energy schemes, their cost benefit analysis,.

Text Books

1. Solar Energy: Principles of Thermal Collection and Storage, S. P. Sukhatme and J. K. Nayak, TMH, New Delhi, 3rd Edition.
2. Renewable Energy Resources, John Twidell and Tony Weir, Taylor and Francis -second edition, 2013.
3. Non-Conventional Energy Sources /G.D. Rai, Khanna Publishers

Reference Books

1. Renewable Energy- Edited by Godfrey Boyle-oxford university, press, 3rd edition, 2013.
2. Handbook of renewable technology Ahmed and Zobaa, Ramesh C Bansal, World scientific, Singapore.
3. Renewable Energy Technologies /Ramesh & Kumar /Narosa.
4. Renewable energy technologies – A practical guide for beginners – Chetong Singh Solanki, PHI.
5. Non conventional energy source –B.H. Khan- TMH-2nd edition.
6. Integrated energy systems modeling--Karlsson, Kenneth Bernard; Skytte, Klaus Morthorst; Published in: DTU International Energy Report 2015.

IV Semester
Department of Electrical Engineering

Course Code : EET275 **Course : Electromagnetic Fields**

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

Course Outcomes

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

CO 1: Understand vector analysis, vector and scalars conversion for different coordinate system like conversion of Cartesian to Cylindrical, Spherical coordinate system and vice versa

CO 2: Understand scalar and vector magnetic and electric field and how to calculate force on steady and moving charge.

CO 3: Apply Coulomb's law, Gauss law, Divergence theorem to electric field intensity i.e. field of 'n' point charges, volume charge, line charge etc.

CO 4: Find potential difference and potential of point charge.

CO 5: Apply effective analysis tool like Poisson's and Laplace equations to current, current density, dielectrics and capacitances, metallic conductors.

CO 6: Understand the nature of dielectric materials like in parallel plate capacitance, two wire line capacitance.

CO 7: Understand steady magnetic field and magnetic forces, also nature of magnetic material. Also how to apply BiotSavorts law, Ampere's circuital law and Stroke theorem to magnetic circuit.

CO 8: Understand the role of Maxwell's equation and boundary conditions.

CO 9: Understand basics of electromagnetic waves.

MODULE 1: [06Hours]

Vector Analysis: Idea of Vector & Scalars, Vector Algebra, Vector addition, vector subtraction, Dot product, Scalar product in Cartesian coordinate system, conversion of variables from Cartesian to cylindrical, Cartesian to spherical and vice versa.

MODULE 2: [06Hours]

Coulomb's law, Electrical field intensity and electric flux density: Coulomb's law, electric field intensity, field often, point charges, field due to continuous volume charge distribution, field of line charge, field of sheet charges concept of flux density.

MODULE 3: [08 Hours]

Gauss's law, Energy and Potential of charge system: Gauss's law, Application of Gauss's law, divergence theorem, definition of potential difference and potential, potential of a point charges, potential field of system of charge, potential gradient, Energy density in Electrostatic field.

MODULE 4: [10 Hours]

Conductors, Dielectric and Capacitance and Poisson's and Laplace's Equations: Current and current density, continuity of current, metallic conductors, conductor properties and Boundary conditions, Nature of Dielectric materials capacitance and capacitances, Capacitance of parallel plate capacitor, Capacitance of two wire line, Poissons and Laplace equations.

MODULE 5: [10Hours]

The Steady Magnetic Field and Magnetic Forces: Biot Savarts law, Ampere's Circuital Law, Strokes theorem, Magnetic flux density, Scalar and Vector Magnetic potentials, force on moving charge, force between differential current elements, nature of Magnetically material, Magnetization and permeability, Magnetic circuits, potential energy, and forces on magnetic materials, Inductance and mutual inductances.

MODULE 6: [02 Hours]

Maxwell's equations and boundary conditions, Elementary idea of Electromagnetic waves,

Text Books

Engineering Electromagnetic:3rd Ed., Mc-Graw Hill, W. H. Hayt

Reference Books

Electromagnetic, Joseph A. Administer

IV Semester
Department of Electrical Engineering

Course Code : HUT252 **Course : Indian Traditional Knowledge**

L: 2 Hrs., T: 0 Hrs., P: 0 Hrs., Per week **Total Credits : 00**

Course outcome

Students will have increased ability to understand the importance and application of:

CO1: Indian Knowledge system and its scientific approach

CO2: Indian philosophical tradition

CO3: Indian artistic tradition

CO4: Traditional knowledge and protection of nature

CO5: The legality and its importance for the protection of Indian traditional knowledge

MODULE 1: [07 Hours]

Basic Structure of Indian Traditional Knowledge: Vedas, Upavedas, Vedang, Upadang, scientific approach

MODULE 2: [05 Hours]

Ecology and Indian Traditional Knowledge: Meaning, role, case studies

MODULE 3: [07 Hours]

Intellectual Property Rights and Indian traditional Knowledge: Meaning, role in protection of Indian traditional knowledge, cases studies

MODULE 4: [07 Hours]

Indian Philosophical traditions: Nyay, Sankaya, Yog, Mimansa, Jainism, Buddhism, Sikhism, and other approaches

MODULE 5: [04 Hours]

Indian Artistic Traditions: Chitrakala, Murtikala, Vastukala, Sangeet, Sthpatya, NrityaevamSahitya, case studies

Reference Material

1. RR Gaur, Rajeev Sangal, GP Bagaria, Human Values and Professional Ethics (Excel Books, New Delhi, 2010)
2. V. Sivaramakrishanan (ed.), Cultural Heritage of India – Course material, BharatiyaVidyaBhavan, Mumbai, 5th Edition, 2014
3. Swami Jitatmanand, Modern Physics and Vedant, BharatiyaVidyaBhavan
4. Swami Jitatmanand, Holistic Science and Vedant, BharatiyaVidyaBhavan
5. S.C. Chatterjee and D.M. Datta, An introduction to Indian Philosophy, University of Calcutta, 1984
6. Pramod Chandra, Indian Arts, Howard University Press, 1984
7. Krishna Chaitanya, Arts of India, Abhinav Publications, 1987.

IV Semester
Department of Electrical Engineering

Course Code : EETH41 **Course : DC Microgrid**

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

Course Objectives

Objectives of this course are to make the students understand the concept of Microgrid in electrical systems, introduce various aspects of DC Microgrid and discuss about the power sources used in DC Microgrid system. This course also focus on the power electronic converters and power flow control strategies used in the DC Microgrid.

Course Outcomes

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

CO 1 : Understand the concepts of Microgrid.

CO 2 : Differentiate between AC and DC Microgrid.

CO 3 : Discuss about the power sources used in DC Microgrid.

CO 4 : Familiaries with power converters used in DC Microgrid.

CO 5 : Understand the control techniques for power flow control in DC Microgrid.

Module 1 :

Brief introduction and Concepts of Microgrid, Types of Microgrid system, Microgrid v/s Central Conventional power system.

Module 2 :

AC and DC Microgrid, comparison between AC and DC Microgrid.

Module 3 :

DC Power source components, applications of DC Microgrid.

Module 4 :

Introduction to Power Electronic Converters in Microgrid application, DC Microgrid Topologies.

Module 5 :

DC Microgrid operations, Some Standards related with DC Circuit.

Module 6 :

Hierarchical Power Sharing Control in DC Microgrid, Control methods in DC Microgrid

Reference Books

1. Microgrid Architectures and Control, by Nikos Hatziargyriou John Wiley Sons, 2014.
2. Urban DC Microgrid : Intelligent Control and Power Flow Optimization, by Manuela Sechilariu, Fabrice Locment, Butterworth-Heinemann, 2016.
3. Advanced Control Methods and Renewable Energy System Integration by Magdi S. Mahmood Butterworth-Heinemann Published Date : 5th October 2016.

IV Semester (Syllabus of Minor Specialization)
Department of Electrical Engineering

Course Code : EETM41 **Course : Electrical Machines**

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

Course Objectives

1. To revive the basics of electromagnetic and electro-mechanical systems.
2. To discuss the constructions, types, working and performance of transformers.
3. To introduce the construction, operation, performance and speed control of DC motors.
4. To introduce the construction, operation, performance and speed control of AC motors.
5. To introduce fractional horsepower motors as used in domestic and industrial applications.

Course Outcomes

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

CO 1 : Apply the electrical rules to understand the working of electric machines and explain the basic terms used in electromagnetic and electro-mechanical systems.

CO 2 : Understand the transformer construction, working, performance and differentiate between its types.

CO 3 : Discuss the construction, working, characteristics of DC motor and understand it's starting and speed control.

CO 4 : Explain the construction, working, characteristics of 3-phase induction motor and understand it's starting and speed control.

CO 5 : Explain the construction and working 3-phase synchronous motor and understand how its power factor can be controlled using the excitation.

CO 6 : Understand the fractional horsepower motors used in domestic and industrial applications.

Syllabus

Module 1 : Basics of Electricity (06 Hrs)

Basic terms as applied to DC and AC circuits, basic terms of magnetic circuits, different types of power, power factor, types of induced EMF, Faraday's law of electromagnetic induction, dot and cross marking, right hand thumb rule, Fleming's right hand and left hand rules, energy balance in electro-mechanical energy conversion, concept of torque.

Module 2 : 1-ph. and 3-ph. Transformer (08 Hrs)

Construction, working principle, types of 3-phase transformer, power and distribution transformer, concept of voltage step-up and step-down in power system with the help of single-line diagram, transformation ratio, operation at no-load and on-load, kVA rating, losses efficiency, voltage regulation (include simple numericals).

Module 3 : DC Motor (06 Hrs)

Construction, working principle of generator and motor, concept of back EMF and counteracting torque, types of DC motor, characteristics of DC motor, losses, motor efficiency, need of starter, speed control by armature voltage and field current control, applications.

Module 4 : 3-Phase Induction Motor (08 Hrs)

Construction and types, working principle, revolving magnetic field, slip, slip frequency, torque-slip characteristics, losses efficiency, basic concept of on-line and reduced voltage starting, speed control by varying stator voltage, stator frequency, V/f method and rotor resistance, applications (Numericals on starting and speed control not included).

Module 5 : 3-Phase Synchronous Motor (07 Hrs)

Construction of salient pole and cylindrical type machine, elementary introduction to alternator, working principle of motor, non-self-starting nature, damper circuit, and equations of induced EMF, phasor diagram, motor V and inverted V curves, applications.

Module 6 : Fractional Horsepower Motors (05 Hrs)

1-Phase induction motor : Split phase type, capacitor type, construction & working torque-speed characteristics, applications. Universal motor : construction, working, applications.

Text Books

1. Electrical Machines by Ashfaq Hussain, Dhanpat Rai & Co. (P) Limited
2. Electrical Machinery by I. J. Hagrath and D. P. Kothari, Tata McGraw-Hill Education, 2004.
3. Electrical Machinery by P. S. Bhimbra, Khanna Publishers.

Reference Books

1. A Text Book of Electrical Technology, Vol. II : B. L. Theraja nad A. K. Theraja.
2. Electrical Machinery, A. E. Fitzgerald and C. Kingsley, McGraw Hill Education, 2013.
3. Performance and design of AC machines, M. G. Say, CBS Publishers, 2002.
4. NPTEL lectures / courses on related topics.

V Semester
Department of Electrical Engineering

Course Code : EET351 **Course : Power System - I**

L: 3 Hrs, T: 0 Hr, P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. To introduce the students to the general structure of Power System from generating stations to the consumer.
2. To expose the students to different electrical and mechanical aspects of Power System.
3. To impart the knowledge of real and reactive power control and optimum generation scheduling.

Course Outcomes

At the end of this course students will demonstrate the ability to

1. Understand basic concepts of power system and evaluate per unit values for various power system components.
2. Determine different electrical and mechanical parameters of overhead transmission lines.
3. Analyse the performance of transmission line
4. Determine parameters of distribution systems and underground cable.
5. Understand and evaluate optimal operation of power system.

Unit I

Basic Concepts : Evolution of Power Systems and Present-Day Scenario. Structure of a power system, Transmission and Distribution Systems, Line diagrams, transmission and distribution voltage levels, overhead and underground system, AC and DC transmission, Transmission Loss. Loads: Types, Voltage and Frequency dependence of Loads, Introduction to per-unit system and per-unit calculations.

Unit II

Transmission Line Parameters : Transmission line parameters, Types of conductors, Electrical and Magnetic Fields around conductors, Capacitance and Inductance calculations for symmetrical and unsymmetrical conductor spacing, Transposition of line, Skin and Proximity effect, bundled conductors, Corona.

Unit III

Performance of Transmission Line : Sinusoidal Steady state representation of Lines: Short, medium and long lines. Performance of transmission line and voltage regulation, Real and reactive power flow in transmission line, Characteristics of transmission lines, Surge Impedance Loading, Series and Shunt Compensation of transmission lines. Concept of Travelling Waves.

Unit IV

Distribution System and Cables : Types of distribution system and its topologies, Feeders, distributors and service mains, Quantitative analysis of DC and AC distributor. Types of Cables, Calculation of Capacitance of single-phase and three-phase Cable, Grading of Cable, Power Factor and Heating of Cable.

Unit V

Mechanical Design of Transmission Line : Line Supports, Types of tower, Stress and Sag Calculation, Effect of Wind and Ice loading, Insulators: Types, Voltage distribution in insulator string, improvement of string efficiency.

Unit VI

Operation of Power System : Concept of Real and Reactive power control, Steady state performance of turbine governors, load sharing between generators, Optimum generation scheduling with and without considering transmission losses.

Text Books

1. Electric Power Systems: C.L.Wadhwa, Wiley Eastern Ltd, New Delhi.
2. Modern Power System Analysis: D. P. Kothari and I. J. Nagrath, McGraw Hill Education, 2003.
3. Principles of Power System: V.K.Mehta, S.Chand ,2005

Reference Books

1. Power System Analysis: J. Grainger and W. D. Stevenson, McGraw Hill Education, 1994.
2. Electric Energy Systems Theory: O. I. Elgerd, McGraw Hill Education, 1995.
3. Power System Analysis: R. Bergen and V. Vittal, Pearson Education Inc., 1999.
4. Electric Power Systems: M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, Wiley, 2012.

V Semester
Department of Electrical Engineering

Course Code : EET352 **Course : Electrical Machines - II**

L: 3 Hrs, T: 1 Hr, P: 0 Hrs. Per week **Total Credits : 04**

Course Objectives

The objective of the course is to prepare the students:

1. To introduce the constructional and operational details of cylindrical and salient pole rotor type synchronous machines working in generator and motor modes.
2. To present the procedure for analysis of synchronous generator and synchronous motor during the (a) steady state, (b) transient state (3-phase short-circuit) and (c) unbalanced operating conditions using phasor diagrams and machine equations.
3. To introduce the methods of synchronization and analysis when alternators are connected to infinite bus and in parallel with each other.
4. To introduce special purpose motors and discuss their construction, working and applications.

Course Outcomes

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

1. Explain the constructional features, working principle, need of damper circuit, and harmonic related aspects of a synchronous machine.
2. Understand the steady state operation of a synchronous machine using phasor equations/ phasor diagram when working as a generator and as a motor and assess the performance under given operating conditions.
3. Analyze the operation/performance of synchronous generator(s) when connected to infinite bus, during synchronization and when connected in parallel.
4. Understand the transient operation (during 3-phase short circuit) and unbalance operation of a synchronous generator and calculate the unknown reactances during such operating conditions.
5. Judge the effect of change in operating condition or change in machine parameter or change in input quantities on the performance of synchronous machine when working as a generator or as a motor.
6. Explain the construction, working principle and applications of various special purpose motors.

Unit I

Synchronous Machines : Introduction, constructional features of cylindrical and salient pole rotor machines, introduction to armature winding and field windings, MMF of armature and field windings induced EMF equation and harmonics.

Unit II

Synchronous generator : Steady state operation of cylindrical and salient pole rotor synchronous generator. Phasor diagram, phasor equations, OC and SC test and calculation of percentage regulation using EMF/ synchronous impedance method.

Unit III

Synchronous motor : Principle of operation of synchronous motor, steady state operation of cylindrical rotor and salient pole synchronous motor, phasor equations and phasor diagram.

Unit IV

Performance of synchronous machines : Synchronous Machines On Infinite Bus, synchronization of alternator with infinite bus, parallel operation and load sharing, power angle characteristic, steady state stability limit and role of damper windings .V curve and inverted V curves for synchronous motors and generators., losses and efficiency.

Unit V

Transient behavior : Sudden three phase short circuit and various component of short circuit current, transient and sub-transient reactance and their measurement, equivalent circuit diagram under steady-state, transient, sub-transient state. Unbalance operation of synchronous machine and measurement of positive, negative and zero sequence reactance, Measurement of Xd and Xq by slip test.

Unit VI

Introduction to Special Machines : Reluctance motor, hysteresis motor, permanent magnet motor, repulsion motor. Universal Motor, linear Induction Motor.

Text Books

1. Electrical Machines:Ashfaq Hussain, Dhanpat Rai & Co. (P) Limited
2. Electrical Machinery: I. J. Nagrath and D. P. Kothari, Tata McGraw-Hill Education, 2004.
3. Electrical Machinery: P.S. Bhimbra, Khanna Publishers.

Reference Books

1. A Text book of Electrical Technology Vol. II: B. L. Theraja and A. K. Theraja.
2. Electric Machinery: A. E. Fitzgerald and C. Kingsley, McGraw Hill Education, 2013.
3. Performance and design of AC machines: M. G. Say, CBS Publishers, 2002.
4. NPTEL lectures/courses on related topics

V Semester
Department of Electrical Engineering

Course Code : EEP352 | **Course : Electrical Machines - II Lab**

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

Course Objectives

The objective of the course is to prepare the students:

1. To acquire the practical knowledge of construction, working and operation of synchronous machines.
2. To introduce the procedure for testing of synchronous machines working in generator and motor modes.
3. To introduce the methods of synchronization and analysis when alternators are connected to infinite bus or in parallel with each other.

Course Outcomes

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

1. Understand and correlate the theoretical knowledge of synchronous machines with laboratory experiments.
2. Select the instruments and apparatus of appropriate rating with recognition of machine ratings and connect the circuit to perform the experiment.
3. Perform the experiment, take readings, analyze the measured data and make valid conclusions.
4. Write effective report with neat and labelled presentation of diagrams, observations, correct calculations and graphs.

Experiments are based on the syllabus of course EET352

Text Books

1. Laboratory Courses in Electrical Engineering: S. G. Tarnekar, P. K. Kharbanda, S. B. Bodkhe, S. D. Naik, D. J. Dahigaonkar, S. Chand Publishing, New Delhi.
2. Electrical Machines: Ashfaq Hussain, Dhanpat Rai & Co. (P) Limited

V Semester

Department of Electrical Engineering

Course Code : EET353 **Course : Microcontroller**

L: 3 Hrs, T: 0 Hr, P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

Objective of this course is to prepare the students to use Microcontroller as a tool for designing and development of electrical and electronic systems.

Course Outcomes

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

1. Understand the architecture and organisation of microcontroller.
2. Use assembly language and Embedded C for microcontroller programming.
3. Carry out initialization of microcontroller peripherals.
4. Implement interfacing of I/O devices.
5. Design simple applications using microcontroller.

Unit I

Introduction to Microcontrollers : Microprocessor and Microcontroller, Overview of microcontroller applications and major families; Microcontroller architecture.

Unit II

Instruction Set Introduction : Addressing modes and Instruction set of a proprietary microcontroller; Microcontroller hardware connection; Interfacing with parallel I/O ports.

Unit III

Peripheral Programming : Timer programming, Analog to digital Conversion, Interfacing of I/O devices; Interrupt programming, working with memories: SRAM, EEPROM, Flash.

Unit IV

Serial Communication : Serial communication using USART, Introduction to I2C Bus

Unit V

Embedded C Programming : C language programming of microcontroller using open source /proprietary software packages in Integrated Development Environment.

Unit VI

Application Development : Introduction to various interactive applications using microcontroller and peripherals, LCD interfacing.

*Proprietary Microcontroller to be announced at the beginning of the course (ATMEL AVR or Microchip or Texas)

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. 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.

Reference Books

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

V Semester
Department of Electrical Engineering

Course Code : EEP353 **Course : Microcontroller Lab**

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

Course Objectives

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:

1. Use open source or proprietary development environment and microcontroller development board for Microcontroller programming. Implement control algorithm using suitable programming language.
2. Set up the circuit on microcontroller development board for testing of program.
3. Debug the program to make it working.
4. Design small application based on microcontroller

Reference Books / Resources

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

V Semester
Department of Electrical Engineering

Course Code : EET354 - 1 **Course : Electrical Machines Design**

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. To present the properties of Electrical Engineering material.
2. To introduce the design principles of magnetic circuits and windings of single & three phase transformers, 3-phase induction motors and electro-magnets.
3. To understand and analyze the performance characteristics from design data of electrical machines such as: transformer, induction motor.
4. To introduce the software tools for design calculations and FEM based machine design.

Course Outcomes

At the end of this course, student will demonstrate the ability to,

1. Understand the properties of electrical engineering materials and able to compute the final temperature attained by machines during heating & cooling process.
2. Design the major parts of transformers, understand the temperature rise, discuss the methods of cooling and evaluate the performance characteristics from the design data.
3. Design the main parts of an Induction motor, describe the effects and methods to reduce the effects of harmonics on the performance of an induction motor and evaluate the operating characteristics of the machine.
4. Discuss different types of electro-magnets and calculate the electro-magnetic pull/force.
5. Use the software tools for design calculations and use of FEM for design.

Unit 1

Introduction : Major considerations in electrical machine design, electrical engineering materials, temperature rise, heating and cooling characteristics, standard specifications, rating of machines: CMR and short time ratings, etc.

Unit 2

Transformer Design : Main Dimensions: KVA output for single and three phase transformers, main dimensions, window space factor, overall dimensions.

Unit 3

Transformer Design : Performance Characteristics: winding resistance, magnetic leakage reactance, regulation, temperature rise in transformers, design of cooling tank, and method for cooling of transformers.

Unit 4

Induction Motor, Stator Design : Output equation, main dimension, choice of specific loadings, stator design, air gap length.

Unit 5

Induction Motor : Rotor Design & operating Characteristics: Rules for selecting rotor slots of squirrel cage machines, design of rotor slots, bars & end rings. Operating characteristics, different types of leakage reactance, magnetizing current.

Unit 6

Design of Electro-magnets : Types of Electro-magnets, magnetic pull/force, ampere turn requirement.

Unit 7

Computer aided design : Limitations (assumptions) of traditional designs, need for CAD analysis. Introduction to FEM based machine design.

Text Books

1. Performance and design of A.C.machines: M.G.Say.
2. Electrical Machine Design: A.K.Sawhney, Dhanpatrai & Sons. Delhi.
3. Principles of Electrical Machine Design: R. K. Agrarwal

Reference Books

1. Electrical Machine Design: Balbir Singh in Brite Students Publications. Pune.
2. Electrical Machine Design: M.V. Deshpande.

V Semester
Department of Electrical Engineering

Course Code : EET354 - 2 **Course : Non Conventional Energy Sources**

L: 3 Hrs, T: 0 Hr, P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. To understand solar energy its radiation, collection, storage and application.
2. To understand the concept, characteristics, operation of Wind energy, Biomass energy, Geothermal energy and ocean energy as alternative energy sources.
3. To study the thermo-electrics and understand the processes of direct energy conversion.

Course Outcomes

At the end of this course students will demonstrate the ability to

1. Understand the applications ways of Solar Energy.
2. Analyze different energy sources cost economics along with their practical operational efficiencies.
3. Compare the advantages and dis-advantages for practical implementation.
4. Apply the fundamental rules of thermo electrics for the conversion systems using various energy sources.

Unit I

Principles of Solar Radiation : Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

Solar Energy Collection : Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors. Solar Energy Storage And Applications: - Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

Unit II

Wind Energy : Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria

Unit III

Bio-Mass : Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation and economic aspects.

Unit IV

Geothermal Energy : Resources, types of wells, methods of harnessing the energy, potential in India.

Unit V

Ocean Energy : OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics.

Unit VI

Direct Energy Conversion : Need for DEC, Carnot cycle, limitations, principles of DEC. Thermoelectric generators, seebeck, peltier and joul Thomson effects, Figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD Engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principles, faraday's law's, thermodynamic aspects, selection of fuels and operating conditions.

Text Books

1. Non-Conventional Energy Sources: G.D. Rai
2. Renewable Energy Technologies: Ramesh & Kumar, Narosa

Reference Books

1. Renewable energy resources: Tiwari and Ghosal, Narosa.
2. Non-Conventional Energy: Ashok V Desai, Wiley Eastern
3. Non-Conventional Energy Systems: K Mittal, Wheeler
4. Solar Energy: Sukhame.

V Semester
Department of Electrical Engineering

Course Code : EET354 - 3 **Course : Electrical Energy Conservation and Audit**

L: 3 Hrs, T: 0 Hr, P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. To make aware with the current energy scenario and importance of energy audit.
2. To introduce with energy saving opportunities in different electrical and industrial systems.
3. To make understand the various effects on environment due to electricity generation with the different protocols at international level.

Course Outcomes

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

1. Understand the basics of energy with material and energy balance.
2. Understand the role of ESCO and analyze the different financial options of investment.
3. Understand details about Electrical Energy consumption, its uses, and its efficiency.
4. Evaluate the performance of Compressed Air System and Heating, Ventilation & Air Conditioning (HVAC)
5. Find out the energy saving opportunities in Pumps, Pumping System and Cooling Towers.
6. Correlate the energy and its effect on environment.

Unit I

Energy Scenario : Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change, Energy Conservation Act-2001 and its features.

Energy Audit : Definition, need, types of energy audit, energy audit instruments.

Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

Unit II

Financial Management : Investment-need, appraisal and criteria, financial analysis techniques - simple payback period, return on investment, net present value, internal rate of return, cash flows, risk and sensitivity analysis; financing options, energy performance contracts and role of Energy Service Companies (ESCOs).

Unit III

Electrical System : Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors. Energy efficient motors, soft starters with energy saver, variable speed drives.

Unit IV

Compressed Air System and (HVAC) : Types of air compressors, compressor efficiency, efficient compressor operation, Heating, ventilation, air conditioning and Refrigeration System:

Fans and blowers : Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities, pressure drop calculation.

Unit V

Pumps and Pumping System : Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Energy conservation in boiler feed water pump, pumping systems for municipal drinking water, and sewerage, agriculture pump sets.

Cooling Tower : Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities assessment of cooling towers.

Unit VI

Energy, Environment and Climate change : Energy and environment, air pollution, climate change United Nations Framework Convention on Climate Change (UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), CDM Procedures case of CDM, Prototype Carbon Fund (PCF). Energy conservation in Buildings and Energy Conservation Building Codes (ECBC): About Energy Conservation Building Codes (ECBC), building envelope, insulation, lighting, Heating, ventilation, air conditioning (HVAC), fenestrations, water pumping, inverter and energy storage/captive generation, elevators and escalators, star labeling for existing buildings, Energy Service Companies based case studies.

Text Books

1. Archie, W Culp. Principles of Energy Conservation: McGraw Hill, 1991.
2. P. O'Callaghan : Energy Management: McGraw Hill Book Company, 1993.
3. Handbook of Energy Engineering: Thuman A and Mehta D Paul, the Fairmount Press.Reference

References

1. Handbook on Energy Audits and Management: Amit Kumar Tyagi.
2. Energy Efficient Buildings: Majumder Milli, TERI.
3. Energy Management: Paul O'Callagh, McGraw Hill.4. Bureau of Energy Efficiency Study material for Energy Managers and Auditors Examination: Paper I to IV.

V Semester
Department of Electrical Engineering

Course Code : EET355 **Course : Power Electronics**

L: 3 Hrs, T: 1 Hr, P: 0 Hrs. Per week **Total Credits : 04**

Course Objectives

The objective of the course is to prepare the students:

1. To study and understand modern power semiconductor devices.
2. To learn various important topologies of power converter circuits, their operation and applications.

Course Outcomes

At the end of this course students will demonstrate the ability to

1. Identify static & dynamic characteristics, ratings and specifications of basic power electronic switches with necessity triggering mechanism and compare these switches depending upon requirement with design of protection parameters for the circuit.
2. Select and compare different static controllable switches depending upon requirement and nature of power electronic controller
3. Design and analyze the different types of AC-DC converters with their performance parameters, output waveforms and applicability depending on nature of load.
4. Design and analyze the DC-DC converters with their performance parameters, output waveforms, applicability depending on nature of load.
5. Design and analyze the operation of DC-AC converters with their performance parameters, output waveforms as per nature of load using different PWM techniques.
6. Classify the recent power electronics devices as per ratings , specifications and applications

Unit I

Power switching devices : Concept of Power Electronics, Scope and Applications, Types of Power Converters, Power Semiconductor Devices -Diodes, SCR, TRIAC, Principles of Operation, Characteristics, Ratings, and Gate Drive Circuits, Switching and Conduction Losses Thyristor protection, Series and Parallel connections of SCRs.

Unit II

Static Controllable Switches : Principles of Operation and V-I Characteristic of Power MOSFET, Insulated Gate Bipolar Transistor (IGBT)and Gate turn off thyristor(GTO), Ratings

Unit III

Thyristor Rectifiers : Working of Single Phase, Three Phase Bridge Converters with R, RL and RLE –Load, Effect of Source Inductance in Converters, Power Factor Improvement, Single Phase Cycloconverter

Unit IV

DC-DC Converters : Introduction, Basic Principles of Step-Down and Step-Up Operation, Chopper Classification, CCM, DCM Modes of Operation, Application of Choppers, Introduction to Forward and Flyback Converters, Ripple factor.

Unit V

DC-AC Converters : Single Phase and Three Phase Bridge Inverters, Output Voltage Control, Harmonics in Output Voltage Waveform, Harmonics Attenuation by Filters, Harmonic Reduction, SPWM, SVPWM, SHEPWM,. Working of Current Source Inverters, few Applications of Inverters, Principle of Resonant Inverter, Introduction of Multilevel Inverter..

Unit VI

Recent Power Electronics Devices and Converters : Resonant Converters, UPS, SMPS, Introduction to SiC, Gan Devices, Matrix converter

Text Books

1. Power Electronics: M. Rashid, Pearson Education India, 2004.
2. Power Electronics: Converters, Applications and Design: N. Mohan and T. M. Undeland,2012, John Willey, 3rd edition.
3. Industrial Power Electronics: Deodatta Shingare, First Edition, Electrotech Publication Pune
4. Power Electronics: M.D. Singh, K.B. Khanchandani, Tata McGraw Hill.

Reference Books

1. Power Electronics: C.Y. Lander., Third Edition, 1993, McGraw Hill International.
2. Principles of Power Electronics: Joseph Vithyathil, First Edition, 2010,Tata McGraw Hill.
3. Fundamentals of Power Electronics: R. W. Erickson and D. Maksimovic, Springer Science & Business Media, 2007.
4. Power Electronics: L. Umanand, Essentials and Applications", Wiley India, 2009.

V Semester
Department of Electrical Engineering

Course Code : EEP355 **Course : Power Electronics Lab.**

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

Course Objectives

The objective of the course is to prepare the students:

1. To familiarize the various switching devices by studying their characteristics.
2. To study the operation of power converters and their applications in various systems for power control by conducting suitable experiments.

Course Outcomes

After completion of this course, students should be able to

1. Apply, analyze and co-relate fundamental principles of science & Engineering with laboratory experimental work
2. Analyze characteristics of different types of power electronics switches
3. Analyze the operation of rectifiers, choppers and inverters
4. Design SIMULINK circuit for verification of various power electronics circuit behavior using Software.
5. Analyze and prepare the technical report on the experiments carried out.

Experiments are based on various switching devices and power converters.

V Semester
Department of Electrical Engineering

Course Code : EEP357 **Course : Electrical Workshop and CAEED Lab**

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

Course Objectives

The objective of the course is to prepare the students:

1. To make aware with the control wiring of DOL and Star-Delta starter.
2. To introduce with transformer and induction motor designing for a particular rating.
3. To make understand the various components in electrical system by drawing the single line diagram.

Course Outcomes

After the completion of this course, the students will be

1. Able to apply, analyze and co-relate fundamental principles of science & engineering with laboratory experimental work
2. The student will be able to design and test the efficiency and regulation of single phase transformer.
3. Able to do control wiring of DOL starter, and Star–Delta Starter for three phase motors.
4. Able to draw the single line diagram of industry and starter drawing in AutoCAD.

Syllabus

1. Introduction to designing of transformer winding. (Hands on).
2. Introduction to designing of three phase induction motor winding. (Theoretical and Demo)
3. Introduction to control panel wiring and drawing (scope is limited to)

a. Direct online (DOL)starter

b. Star- delta starter

c. Drawing using AutoCAD software and Matlab simulation

4. Industry visit for Electrical Installation Layout (EIL) study
5. Drawing of EIL using CAEED tool

Text Books

1. L and T motor Starter Handbook

V Semester
Department of Electrical Engineering

Course Code : EET398 - 1 **Course : Energy Management and Audit**

L: 3 Hrs, T: 0 Hr, P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. To make aware with the current energy scenario and importance of energy audit.
2. To introduce with energy saving opportunities in different electrical and industrial systems.
3. To make understand the various effects on environment due to electricity generation

Course Outcomes

At the end of this course students will demonstrate the ability to

1. Understand the current energy scenario and importance of energy conservation.
2. Understand the concepts of energy management.
3. Understand the methods of improving energy efficiency in different electrical systems.
4. Understand the methods of improving energy efficiency in different industrial systems.
5. Understand the concepts of different energy efficient devices.

Unit I

Energy Scenario : Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change, Energy Conservation Act- 2001 and its features.

Unit II

Basics of Energy and its various forms : Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

Unit III

Energy Management & Audit : Definition, energy audit, need, types of energy audit. Energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies,optimizing the input energy requirements, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

Unit IV

Energy Efficiency in Electrical Systems : Electrical system: performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

Unit V

Energy Efficiency in Industrial Systems : Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC.

Fans and blowers : Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.

Pumps and Pumping System : Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.

Cooling Tower : Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers.

Unit VI

Energy Efficient Technologies in Electrical Systems : Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

Text / Reference Books

1. Guide books for National Certification Examination for Energy Manager / Energy
2. Auditors Book-1: General Aspects (available online)
3. Auditors Book-3: Electrical Utilities (available online)
4. Utilization of Electrical Energy and Conservation: S. C. Tripathy, McGraw Hill, 1991.
5. Success stories of Energy Conservation: BEE, New Delhi (www.bee-india.org)

V Semester
Department of Electrical Engineering

Course Code : EET398 - 2 **Course : Microcontroller Applications**

L: 3 Hrs, T: 0 Hr, P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

The objective this course is to prepare the students to use Microcontroller as tool for the design and development of control applications.

Course Outcomes

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

1. Understand the architecture and organization of microcontroller.
2. Develop programs using microcontroller instruction set and Embedded C.
3. Initialize various peripherals of microcontroller as per the application requirement.
4. Develop programs for interfacing of I/O devices.
5. Develop interactive applications using microcontroller.

Unit I

Introduction to Microcontrollers, Microprocessor and Microcontroller, Overview of microcontroller applications and major families, Microcontroller architecture.

Unit II

Assembly Language Programming, Addressing modes and Instruction set of a *proprietary microcontroller, Microcontroller Hardware connection; Interfacing with parallel I/O ports, LED and LCD Interfacing.

Unit III

Timer programming, Interrupt programming; Interfacing I/O devices, Analog to Digital Conversion, Working With Memories: SRAM, Flash, EEPROM.

Unit IV

Serial Communication, I2C Bus, Reading / Writing RTC using I2C.

Unit V

Assembly and C language programming of microcontroller using open source/proprietary software packages in Integrated Development Environment.

Unit VIApplication development: Driver design for various applications such as DC motors, Real Time Clock based application, Interactive Apps using Buttons, Menu Driven Programming.

* Proprietary Microcontroller to be announced at the beginning of the course (ATMEL AVR or Microchip or Texas)

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. Embedded C Programming and the Atmel AVR: Richard Barnett, Larry O'Cull and Sarah Cox, Delmar, Cengage Learning, 2nd Edition
3. Go Embedded: AsangDani, Yeshwant Kanetkar, B.P.B. Publication2nd Edition

Reference Books

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

V Semester
Department of Electrical Engineering

Course Code : EET398 - 3 **Course : Industrial Instrumentation**

L: 3 Hrs, T: 0 Hr, P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. To equip the students with relevant knowledge to suit the industrial requirements.
2. To provide the knowledge about various techniques used for the measurement of industrial parameters.
3. To have an adequate knowledge about electrical and mechanical transducers for measurements of various physical quantities.

Course Outcomes

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

1. Select the instruments for measurement of various physical quantities,
2. Select the instruments for measurement of various electrical quantities,
3. Understand the necessity of signal conditioning in Instrumentation system,
4. Suggest the signal transmission protocol required for the Instrumentation system.

Unit I

Introduction to Industrial Instrumentation : Definitions, Dynamic Characteristics of Instruments, Zero-Order Instrument, First-Order Instrument, Second-Order System.

Pressure Measurement: Introduction, Basic terms, Pressure formulas, Pressure measuring instruments, Application considerations.

Unit II

Temperature and Heat Measurement : Introduction, basic terms, Temperature and heat formulas, Temperature measuring devices, Application considerations

Unit III

Level Measurement : Introduction, basic terms, Level formulas, Level sensing devices, Application considerations.

Flow Measurement : Introduction, basic terms, Flow formulas, Flow measuring instruments, Application considerations.

Unit IV

Position and motion sensing : Basic definitions, measuring devices, application considerations.

Force, Torque and Load cell : Basic definitions, measuring devices, application considerations

Unit V

Electrical Measurement : True RMS Measurement of electrical quantities like Voltage, Current, Power.

Sound and Light Sensors : Formulas, Basic definitions, measuring devices, application considerations

Unit VI

Signal Conditioning : Conversion of various transducer signals into electrical signals, Signal conditioning circuits, Analog to digital conversion (ADC), Errors in ADC, Selection of ADC,

Signal Transmission : Transmission of signals in analog and digital forms, 4-20 ma, RS232,RS485, MODBUS concept

Text Books

1. Industrial Instrumentation: K Krushnaswamy, New Age International

Reference Books

1. Fundamentals of Industrial Instrumentation and Process Control: William C. Dunn, TMH Publication, 2nd edition.
2. Industrial Instrumentation & Control: S. K. Singh, McGraw-Hill.

V Semester
Department of Electrical Engineering

Course Code : EETH51 **Course : Introduction to Smart Grid**

L: 3 Hrs, T: 1 Hr, P: 0 Hrs. Per week **Total Credits : 04**

Course Objectives

The objective of the course is to prepare the students:

1. Understand concept of smart grid and its advantages over conventional grid.
2. Know smart metering techniques, learn wide area measurement techniques.
3. Summarize the smart solutions for the power system of the future with integration of distributed generation, microgrid etc.

Course Outcomes

At the end of this course students will demonstrate the ability to

1. Understand the fundamental structure of smart grid.
2. Apply smart technologies and smart metering concepts to industrial and commercial installations.
3. Analyze the models of distributed energy resources, their monitoring and protection issues.
4. Understand communication and networking technologies involved with the smart grid.

Unit I

Introduction to Smart Grid : Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Concept of Robust & Self-Healing Grid, Difference between conventional & Smart Grid, Key Challenges for Smart Grid, Present development & International policies/standards in Smart Grid.

Unit II

Technologies of Smart Grid-1 : Architecture, advanced metering infrastructure (AMI), smart metering, Automatic Meter Reading (AMR), Distribution automation.

Unit III

Technologies of Smart Grid-2 : Smart substations, basics of SCADA, Intelligent Electronic Devices (IED) & their application for monitoring & protection, Wide Area Measurement System (WAMS), Phasor Measurement Unit (PMU).

Unit IV

Distributed Energy Resources : Introduction, Advantages and disadvantages of distributed generation (DG), Solar, Wind etc.

Unit V

Microgrid : Concept of micro grid, need & applications of micro grid, formation of micro grid, issues of interconnection, protection & control of micro grid.

Unit VI

Communication Technology for Smart Grid : High Performance Computing for Smart Grid Applications: Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), Basics of Web Service and CLOUD Computing etc. to make Smart Grids smarter.

Text Books

1. Introduction to the Smart Grid: Concepts, Technologies and Evolution, S.K. Salman, IET energy engineering series.
2. Smart Grid: Technology and Applications, Janaka Ekanayake et. al., John Wiley & Sons
3. Power system protection in smart grid environments: Ramesh Bansal, Taylor & Francis; CRC

Reference Books

1. Smart Grid Fundamentals of Design and Analysis: James Momoh, Wiley, 2012
2. NPTEL: Introduction to Smart Grid, Online catalogues of smart meters, PMUs, BCUs etc., Publications in reputed Springer, IEEE Transactions and Elsevier Journals.

V Semester
Department of Electrical Engineering

Course Code : EETM51 **Course : Power Semiconductor Based Drives**

L: 3 Hrs, T: 0 Hr, P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. To familiarize with the different types of power electronics devices.
2. To introduce with the operation and performance of DC and AC Drives.
3. To make understand various control techniques used in the control of the machines.

Course Outcomes

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

1. Select proper power electronic converter to control speed of D.C. motor, 3 phase Induction motor, Synchronous motor and select controlling parameter depending on the application of motor.
2. Compare the electric and non electric traction system with conventional methods of operation of traction system.
3. Understand the basics of electric vehicle with advanced motor drives.

Unit I

Thyristors : Characteristics of Semiconductor Power Devices, Thyristor, power MOSFET and IGBT structure, Characteristics, operation, ratings, protections and thermal considerations, Concept of fast recovery and schottky diodes as freewheeling and feedback diode.

Unit II

Controlled Rectifiers, Choppers & Inverters : Controlled Rectifiers: Single phase: Study of semi and full bridge converters for R, RL and RLE and Analysis of load voltage and input current- Derivations of load form factor and ripple factor, Input current Fourier series analysis of input current to derive input supply power factor, displacement factor and harmonic factor.

Principles of step down chopper, step up chopper, classification of choppers.

Classification of Inverter : Voltage Source Inverter and Current Source Inverter, Principle of operation of full bridge square wave, quasi-square wave, PWM inverters and comparison of their performance, Single phase and three phase bridge inverters, causes of generation of harmonics and reduction techniques using PWM method. Concept of Cycloconverter.

Unit III

Electrical Drives : Dynamics of electric drives and control of electric drives, energy conservation in electric drives

Unit IV

DC Motor Drives : Introduction of D.C. Motor drives, controlled rectifier fed D.C. Drives, single phase and three phase rectifier control of D.C. separately excited motor. Dual converter control of D.C. separately excited motor. Power factor supply harmonics and ripplein motor current. Chopper controlled DC drives of separately excited DC motor chopper control of series motor, source current harmonics.

Unit V

Induction Motor Drives : Introduction of Induction motor drives, stator voltage control, variable frequency control using voltage source inverter, current source inverter & cycloconverter.

Unit VI

Synchronous Motor Drives & Advanced Motor Drives : Introduction of Synchronous Motor Drives, starting, braking of synchronous motor, variable frequency control, self controlled synchronous motor drive employing load commutated Thyristor inverter or cycloconverter, starting of large synchronous motors.

Brushless DC motor and switched reluctance motor drives.

Text Books

1. Power Electronics Circuits Devices & Application: M. H. Rashid
2. Thyristor& their Application: G. K. Dubey & Joshi & Doralba
3. Fundamentals of electric drives: G. K. Dubey.
4. Modern Electric Traction: H. Pratap.
5. Electric drives concepts and applications: V. Subramanan.

Reference Books

1. Power Electronics: P.S. Bimbhra
2. Power electronics: Ned Mohan, Robbins, John Wiley and sons, 3rd edition
3. Electrical Drives: Jon Boldea, N.A. Nasar
4. Electrical Drives Control: R. Krishnan

VI Semester
Department of Electrical Engineering

Course Code : EET371 **Course : Power System - II**

L: 3 Hrs, T: 0 Hr, P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. To understand and analyze the different types of faults in Power system.
2. To understand basic electricity market principles and power exchange.
3. To study concept of power system stability and its analysis;
4. To understand and study the modern power system concepts like SCADA, PMU, security analysis.

Course Outcomes

At the end of this course students will demonstrate the ability to

1. The students should be able to analyse three phase fault for small power systems
2. The students should be able to understand concept of symmetrical components and evaluate the symmetrical components under fault conditions.
3. The students should be able to analyse unsymmetrical faults for small power networks
4. The students should be able to understand Electricity market concepts of deregulated power system and demand side management
5. The students should be able to apply the knowledge for stable operation of power system and analyze the stability of power system
6. The students should be able to understand importance and concepts of secured operation of power system.

Unit I

Symmetrical Fault Analysis : Symmetrical fault analysis without and with pre-fault load currents, selection of circuit Breakers ratings, current limiting reactors.

Unit II

Symmetrical Components : Symmetrical Component transformation, Three phase power in unbalanced circuit in terms of symmetrical component, Sequence impedances of Generator,Transformer, Transmission line and Passive loads, Phase Shift in Star/delta three phase transformer (Yd1, Yd11 connection).

Unit III

Unsymmetrical Fault Analysis : Unsymmetrical fault Analysis – L-G, L-L-G, L-L, Open Conductors faults analysis using symmetrical components.

Unit IV

Power System Economics and Management : Basic Pricing Principles, Generator Cost Curves, Utility Functions, Power Exchanges, Spot Pricing, Electricity Market Models (Vertically Integrated, Purchasing Agency, Whole-sale competition, Retail Competition), Demand Side-management, Transmission and Distributions charges, Ancillary Services, Regulatory framework.

Unit V

Power system stability : Swing Equations of a synchronous machine connected to an infinite bus, Power angle curve, Description of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance like a three-phase fault, Analysis using the Equal Area Criterion, Impact of stability constraints on Power System Operation, Effect of generation rescheduling and series compensation of transmission lines on stability.

Unit VI

Power system security : Overview of Energy Control Centre Functions, SCADA systems, Phasor Measurement Units and Wide-Area Measurement Systems, State-estimation, System Security Assessment, Normal, Alert, Emergency, Extremis states of a Power System, Contingency Analysis, Preventive Control and Emergency Control.

Text Books

1. Power System Analysis: J. Grainger and W. D. Stevenson, McGraw Hill Education,1994.
2. Electric Energy Systems Theory: O. I. Elgerd, McGraw Hill Education, 1995.
3. Power System Analysis: A. R. Bergen and V. Vittal, Pearson Education Inc., 1999.
4. Modern Power System Analysis: D. P. Kothari and I. J. Nagrath, McGraw Hill Education, 2003.

Reference Books

1. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, " Electric Power Systems", Wiley, 2012.
2. Internet websites: Other reference material (e.g. e-resources)

VI Semester
Department of Electrical Engineering

Course Code : EEP371 | **Course : Power System - II Lab**

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

Course Objectives

The objective of the course is to:

1. Make students familiar with concepts and analysis of power systems
2. Make students familiar with prototype model of power system
3. Make students able for understanding, analyzing performance of power system
4. Make students able to understand and correlate the theory with experiments based on power system.

Course Outcomes

Upon successful completion of the course, the student shall be able to

1. Apply and analyze fundamental principles of power system Engineering with laboratory experimental work and programming work
2. Understand and perform the experiment, Analyze the observed data & make valid conclusion
3. Write Journal with effective presentation of diagrams and characteristics
4. Use the modern software like MATLAB for plotting and analyzing power system.

List of Experiments

Experiments will be based on transmission line prototype model and analysis using softwares like ETAP, MATLAB etc

Text Book

Modern Power System Analysis: Nagrath and Kothari

Reference Books

1. Eleictric Energy Systems: Olle Elgerd
2. Power system Stability: Prabha Kundur

VI Semester
Department of Electrical Engineering

Course Code : EET372 **Course : Control Systems**

L: 3 Hrs, T: 1 Hr, P: 0 Hrs. Per week **Total Credits : 04**

Course Objectives

The course will prepare students

1. To understand the concept of feedback systems
2. To understand how the feedback and various controllers are utilized to improve the system performance
3. To analyze the performance of the system by classical and modern control system techniques
4. To understand the operation of the various practical control systems

Course Outcomes

Upon completion of course, students,

1. Will be able to convert physical models into physical systems and then formulating the appropriate mathematical model and converting mathematical models into the block diagrams/ signal flow graphs and then evaluate the transfer function of the system
2. Will be able to understand various time response specifications, perform time response analysis and apply techniques of compensation for improving the system response.
3. Will be able to apply various tools to determine the absolute stability of the systems by applying Routh's Criterion and to understand how the same can be applied to evaluate relative stability.
4. Will be able to understand the concept and application of root locus.
5. Will be able to understand the concept of, Bode plots, Nyquist plots for design and analysis of a system.
6. Will be able to understand and apply the concept of modern control system theory for design and analysis of a system

Unit I

Introduction to Control Problem : Industrial Control examples, Mathematical models of physical systems, Control hardware and their models, Transfer function models of linear time invariant systems, Feedback control, Open loop and closed loop systems, Benefits of feedback, Block dig and signal flow graph algebra

Unit II

Time Response Analysis: - Standard test signals, Time response of first and second order systems for standard test inputs, Application of initial and final value theorem. Design specifications for second order systems based on the time response.

Unit III

Control System stability : Concept of Stability, Stability types, Routh's and Hurwitz Criteria, Relative and conditional stability analysis.

Unit IV

Root Locus Techniques : Concept and use of root locus, Magnitude and angle criteria, Construction of root loci, effect of addition and poles and zeros on root loci

Unit V

Frequency Response Analysis : Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion, Relative stability using Nyquist criterion gain and phase margin, Closed-loop frequency response, Introduction to lag, lead, lag-lead compensation

Unit VI

State Variable Analysis : Concepts of state variables, State space model. Diagonalization of State Matrix, State model in canonical and phase variable form, eigenvalues and Stability Analysis, Finding transfer function from state model

Text Books

1. Control Systems: Principles and Design: M. Gopal, McGraw Hill Education, 1997.
2. Modern Control Engineering: K. Ogata, Prentice Hall, 1991.
3. Control Systems Engineering: I. J. Nagrath and M. Gopal, New Age International,2009

Reference Books

1. Automatic Control System: B. C. Kuo, Prentice Hall, 1995.
2. Other reference material (e.g. e-resources): MATLAB software

VI Semester
Department of Electrical Engineering

Course Code : EEP372 **Course : Control Systems Lab**

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

Course Objectives

The objective of this course is to

1. Make students familiar with concepts and analysis based on classical and advanced control system methods.
2. Make students familiar with working of various control system components.
3. Make students able for understanding, analyzing performance of various control systems and improvement of the performance of various control systems.
4. Make students able to understand and correlate the theory with experiments based on control systems.

Course Outcomes

Upon successful completion of the course, the student shall be able to

1. Apply and analyze fundamental principles of Control System Engineering with laboratory experimental work and programming work
2. Understand and perform the experiment, Analyze the observed data & make valid conclusion
3. Write Journal with effective presentation of diagrams and characteristics
4. Use the modern softwares like MATLAB for plotting and analyzing time response and frequency response and obtain optimal system design

List of Experiments: I SET

1. To study potentiometer as error detector.
2. To study synchro as error detector.
3. To plot torque-speed characteristic of ac servo motor.
4. To study temperature control system.

II SET

5. To study dc position control system.
6. To study dc motor speed control system and to find open loop and closed loop T.F.
7. To study time response of second order system.
8. To study frequency response of second order system.

III SET : Experiments Based On "MATLAB" Software.

9. To plot time response of second order system and to determine time domain specifications.
10. To plot the root locus of given open loop TF and to find all details
11. To study the effect of addition of open loop poles and zeros on root locus.
12. To draw bode plot of given open loop TF and to find GM and PM

Text Book

1. Control Systems Engineering: Nagrath and Gopal

Reference Books

1. Modern Control Theory: M.Gopal
2. Automatic Control Systems: B.C.Kuo (PHI)
3. Linear System Design: D'azzo and Houpis (M.H.)

VI Semester
Department of Electrical Engineering

Course Code : EET373 - 1 **Course : PLC and SCADA**

L: 2 Hrs, T: 0 Hr, P: 1 Hrs. Per week **Total Credits : 03**

Course Objectives

An objective of this course is to introduce the basics of PLC & SCADA, its components and controls to the students. Students will be made familiar with the designing of application in PLC & SCADA.

Course Outcomes

Upon the completion of this course, students will be able to...

1. Understand automation tools & its components.
2. Apply logic with ladder diagram for the industry application.
3. Understand the functioning of PLC & SCADA.
4. Apply knowledge of PLC & SCADA for design of industrial automation.

Unit - I

Introduction to PLC : Technical Definition, advantages, chronological Evolution, Types of PLCs, Block Diagram, processor software/Executive software. PLC vs PC

Unit - II

Ladder diagram fundamentals : Introduction to basic components and their symbols, development of relay and contactor logic, Concept of PCC, MCC, Control desk , No, NC switches, limit switches, relay, relay board, contactor, timer, voltage to current converter, current to voltage converter, solenoid valve, Electrically Hydraulic & pneumatic control, Hydraulic electric power pack, Hydraulic motor control, selection of sensor, fundamentals of Ladder Diagrams.

Unit - III

Fundamental PLC programming : Ladder diagram, physical component vs program components, examples, ladder diagram having more than one rung.

Unit - IV

Advanced programming technique : Addressing Data files, format of logical address Different addressing types, PLC input output modules and power supply.

Unit - V

Industrial Communication and networking : evolution of Industrial Communication technology, types of communication interfaces, synchronization and timing in communication.

Unit - VI

Introduction to Industrial Automation : Industrial automation components, smart sensors, PLC, DCS and SCADA. Introduction to SCADA. Examples of some simple automated systems.

Text Books

1. Programmable Logic Controllers and Industrial Automation: An Introduction Madhuchchanda Mitra, Samarjit Sengupta (Author), 2nd Edition,

Reference Books

1. Programmable Logic Controllers: John Hacworth and Frederick D. Hackworth Jr, Pearson publisher
2. Programmable Logic Controllers: W. Bolton , Newnes an imprint of Elesevier, 6th edition.

Experiments based on above syllabus

1. Simple ON-OFF operation of Lamp using Toggle or push Button
2. Combinational Logic design and implantation on PLC
3. Power ON Delay using PLC
4. Power OFF Delay using PLC
5. Sequential operation using PLC
6. Study of timers from PLC
7. Proxy sensing using PLC (Inductive & Optical)
8. Use of Limit Switch
9. Use of magnetic read sensing
10. Level sensing using Magnetic float switch
11. Temperature measurement using PLC
12. Heater Actuation with Temperature sensing (Temp Control)
13. Motor ON-OFF and Forward/Reverse operation using PLC
14. Counting applications using PLC

VI Semester

Department of Electrical Engineering

Course Code : EET373 - 2 **Course : Power Station Practice**

L: 3 Hrs, T: 0 Hr, P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

1. To solve the load problems along with the load study of practical parameters.
2. To understand the practical aspects of plant capacity, economics and billing system.
3. To understand the practical aspects of working of all conventional power stations.
4. To understand the workings of major equipments, different excitation systems, captive and cogeneration

Course Outcomes

At the end of this course students will demonstrate the ability to,

1. Participate in the Load Calculation, Operation and Distribution, and will be able to classify the load with their properties.
2. Take part in the practices of execution, operation, testing, cost and technical anaysis, developments, deterioration evaluation of important parts of different conventional power stations.
3. Compare the advantages and dis-advantages for practical implementation of different stations.
4. Understand the working of different parts for voltage and frequency control. Take part in interconnections of different power stations proving the cost and efficiencies of generation of power.

Module- I : Sources of Electrical Energy : Coal, oil and natural gas, water power, nuclear fission and fusion. Recent development in power generation.

Electrical Load & Curves : Different factors connected with a generating station, connected load, maximum demand, demand factor, load factor, diversity factor, plant capacity and utilization factor, load curve, load duration curve, load survey, base load and peak load station, advantages of interconnection. load forecasting. (7 Hrs)

Module-II: Plant Capacity & Economics : Choice of site, size and number of units, Cost of electrical energy, Depreciation of plant, Effect of Load Factor, Tariff: different consideration of Flat & two part economical choice. (7Hrs)

Module-III : Thermal Stations : General layout, major equipment, essential and non- essential auxiliaries, electric supply to auxiliaries, cost of generation, effect of different factor on costs. Treatment on water, Tests on coal, Automatic control of different system. Advantages and disadvantages. (7 Hrs)

Module-IV : Hydro station : Hydrology, stream flow, flow duration curve, power duration curve, mass curve and reservoir capacity, type of hydro plants and their field of use, pumped storages plants and their utility, surge tanks, governing characteristics of turbine and hydro generators. Advantages and disadvantage. (7 Hrs)

Module- V: Nuclear station : Principle of Nuclear energy, materials, types of nuclear reactors, breeder reactors, location, material for moderator and control rods, cost economics. (7 Hrs)

Module-VI: Voltage control of A.C. generators: Methods of stabilizing exciter voltage, Automatic Voltage regulator action. Captive & Cogeneration. (7 Hrs)

Text Books

1. Modern Power Station Practice: Turbines, Generators and Associated Plant Vol C, Publisher: Pergamon; 3rd Revised edition E,dition (31 December 1992)
2. Generation of Electrical Energy: Dr. B. R. Gupta, Publisher: S Chand (1 December 2010)
3. Power Plant Engineering: P. C. Sharma, Publisher: Kataria, S. K., & Sons (2004)

Reference Books

1. Electrical Power Station Control: H.P. Young..Vol-XI, Publisher: Chapman and Hall Ltd, London.
2. Elements of Power Station Design: M.V.Deshpande. Edition:Reprint, Publisher: PHI Learning, Pvt. Ltd., 2009.
3. Electric Power Generation the Changing Dimensions: Digambar M. Tagare, Publication by John Wiley & Sons, Inc IEEE Press.
4. Power Plant Engineering: P. K. Nag, Publisher: Tata Mc Graw - Hill Education, Edition: 2nd, 2001.

VI Semester
Department of Electrical Engineering

Course Code : EET373 - 3 **Course : Utilization of Electrical Energy**

L: 3 Hrs, T: 0 Hr, P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. To train students on characteristics of various Heating, Welding methodologies, Illumination methods and traction supply system.
2. Understanding of the concepts of Electrolysis processes, DG system and design of domestic wiring.

Course Outcomes

At the end of this course students will demonstrate the ability to

1. The students should be able to understand the process and application of different types Electric Heating and Welding equipments.
2. The students should be able to design illumination systems for lighting design by applying the fundamentals and by understanding basics of illumination
3. The students should be able to understand Electric Traction system with its power supply structure.
4. The students should be able to understand the working principles and applications for various electrolytic processes for industrial applications.
5. The students should be able to select proper rating of DG sets, know the operational factors and know the design aspects of domestic electrical wiring.

Unit I

Electric Heating and Welding : I) Electric Heating: Types and methods of electrical heating, advantages of electrically produced heat, types & application of electric heating equipment

II) Importance, Advantages & Disadvantages of welding, classification of welding processes, Resistance welding, Electric arc welding, Ultrasonic welding, electron beam welding, laser beam welding.

Unit II

Illumination and Lighting Systems : Nature of light, terms used in illumination, solid angle, laws of illumination, polar curves, basics of CFL, LED & Plasma, Lux level requirements for various applications, classification of light fittings and luminaries, factors affecting the design of indoor lighting installations, total lumen method of calculation,Lighting design for indoor applications, Outdoor lighting system design for street lighting and flood lighting.

Unit III

Electric Traction Supply system : Features of an Ideal Traction System, Advantages and Disadvantages of Electric Traction, System of Traction, Traction Supply System, Transmission system for Traction substation, Feeding and Distribution System on an AC Traction, System of Current Collection, Booster Transformer.

Unit IV

Electrolytic Processes : Fundamental principles, laws of electrolysis, Extraction & Refining of metals, Electro-deposition, Electro plating, Anodizing, manufacture of chemicals, Power supply for electrolytic processes.

Unit V

Diesel Generating Systems : Introduction, selection and installation factors, operational factors, energy performance assessment in DG sets, energy saving measures for DG sets.

Unit VI

Electrical Wiring : Introduction, Basics of Domestic Electrical Wiring, Types of Cables, Flexible Wires Sizes and Current Capacity

Text Books

1. Utilization of Electric Energy: E. Open shaw Taylor, Orient Longman.
2. Utilization of Electric Power & Electric Traction: J.B. Gupta, Kataria & Sons.
3. Art and Science of Utilization of Electrical Energy: H Partap, Dhanpat Rai & Sons, Delhi

Reference Books

1. Guide book for National Certification Examination for Energy Managers and Energy Auditors, Bureau of Energy Efficiency.
2. Other reference material (e.g. e-resources): Catalogues of wires, lighting accessories.

VI Semester
Department of Electrical Engineering

Course Code : EET374 - 1 **Course : Electrical Drives and Control**

L: 3 Hrs, T: 0 Hr, P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. To impart knowledge about fundamentals of electric drives and control, operational strategies of dc and ac motor drives.
2. To justify the selection of drives for various application.
3. To provide knowledge about operation of contactors.
4. To know the performance and suitability of motors in ac/dc traction.
5. To provide knowledge about basic PLC programming in electrical drives.

Course Outcomes

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

1. Examine factors governing selection of Electric Motors for particular application in a common electric drive system.
2. Select motor rating of common drive motors for continuous and intermittent periodic duties.
3. Analyze control circuit of ac/dc contactors and relays.
4. Analyze the performance and suitability of motors used in ac/dc traction.
5. Apply basic PLC programming in electrical drives.

Unit I

Industrial Application of Electric Motors : Factors governing selection of Electric Motors, Types of Drives and types of load, starting of electric motors, Speed control of Electric motors. Definition classification and speed torque characteristics of common drive motors and their characteristics under starting, running, Electric Braking, Types of enclosures.

Unit II

Selection of Motors: Size & Rating : Insulating materials, Temperature rise in Electrical machines, Duty cycles, Power capacity for continuous and intermittent periodic duties, Load equalization and flywheel effect. Brief idea about drives commonly used in industries.

Unit III

Contactors : Control devices for industrial motors, AC and DC contactors and relays: Lock out contactors, magnetic structure, operation, arc interruption, contactor rating, and H.V. contactors. Control circuits for automatic starting and braking of DC motor and three phase induction motor.

Unit IV

Motors for Electric Traction : Different systems of Traction. Train movement and energy consumption. Traction Motors: Motors used in AC/DC traction, their performance and desirable characteristics, requirements and suitability of motor for traction duty.

Unit V

Control of Electric Traction Motors : Traction motor control – Starting and speed control traction motors. Series parallel control with numerical. Starting and speed control of 3-phase induction motors. Braking of traction motor

Unit VI

Introduction to PLC : PLC, its programming and applications in electrical drives.

Text Books

1. Utilization of Electric Power and Electric Traction: J. B. Gupta, Volume IV, S. K. Kataria & Sons publisher
2. A textbook of Electrical Technology: B. L. Theraja & A. K. Theraja, Volume III, S. Chand Publication

Reference Books

1. A textbook on Power System Engineering: A. Chkrabarti, M.L. Soni, P.V. Gupta & U. S. Bhatanagar, Dhanpat Rai & Co. Publisher.
2. Magnetic Control of Industrial Motor: Heumann.
3. Performance and design of AC machines: M. G. Say, CBS Publishers, 2002.
4. NPTEL lectures/courses on related topics.

VI Semester
Department of Electrical Engineering

Course Code : EET374 - 2 **Course : HVDC Transmission Systems**

L: 3 Hrs, T: 0 Hr, P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. To provide knowledge about comparison of HVDC and EHVAC transmission system.
2. To provide knowledge about control and operation of Power electronics in HVDC system.
3. To provide knowledge about power system stability in HVDC system.

Course Outcomes

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

1. To study the advantages of dc transmission over ac transmission.
2. To study the operation of line commutated converters and voltage source converters
3. To study the control strategies used in HVDC transmission system.
4. To analyze the improvement of power system stability using an HVDC system.

Unit I

DC Transmission Technology : Comparison of AC and dc Transmission(Economics, Technical Performance and Reliability).Application of DC Transmission. Types of HVDC systems, Components of a HVDC system, Line Commutated Converter and Voltage Source Converter based systems.

Unit II

Analysis of Line Commutated and Voltage Source Converters : Line Commutated Converters (LCCs): Six pulse converter, Analysis neglecting commutation overlap, harmonics, Twelve Pulse Converters, Inverter Operation, Effect of Commutation Overlap, Expressions for average dc voltage, AC current and reactive power absorbed by the converters, Effect of Commutation Failure, Misfire and Current Extinction in LCC links, Voltage Source Converters (VSCs): Two and Three-level VSCs. PWM schemes: Selective Harmonic Elimination, Sinusoidal Pulse Width Modulation, Analysis of a six pulse converter, Equations in the rotating frame. Real and Reactive power control using a VSC.

Unit III

Control of HVDC Converters : Principles of Link Control in a LCC HVDC system. Control Hierarchy, Firing Angle Controls– Phase-Locked Loop, Current and Extinction Angle Control, Starting and Stopping of a Link, Higher level Controllers Power control, Frequency Control, Stability Controllers, Reactive Power Control. Principles of Link Control in a VSC HVDC system: Power flow anddc Voltage Control, Reactive Power Control/AC voltage regulation.

Unit IV

Components of HVDC systems : Smoothing Reactors, Reactive Power Sources and Filters in LCC HVDC systems DC line: Corona Effects, Insulators, Transient Over-voltages, dc line faults in LCC systems. dc line faults in VSC systems. dc breakers, Monopolar Operation, Ground Electrodes.

Unit V

Stability Enhancement using HVDC Control : Basic Concepts: Power System Angular, Voltage and Frequency Stability, Power Modulation: basic principles – synchronous and asynchronous links. Voltage Stability Problem in AC/DC systems.

Unit VI

MTdc Links : Multi-Terminal and Multi-Infeed Systems, Series and Parallel MTdc systems using LCCs, MTdc systems using VSCs, Modern Trends in HVDC Technology, Introduction to modular Multi-level Converters.

Text Books

1. HVDC Power Transmission Systems: K. R. Padiyar, New Age International Publishers, 2011.
2. High Voltage Direct Current Transmission: J. Arrillaga, Peter Peregrinus Ltd., 1983.
3. Direct Current Transmission: E. W. Kimbark, Vol.1, Wiley-Interscience, 1971.

Reference Books

1. High Voltage Direct Current Transmission: J. Arrillaga, Peter Peregrinus Ltd., 1983.
2. NPTEL /online lectures.

VI Semester
Department of Electrical Engineering

Course Code : IDT353 **Course : Biology for Engineers**

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

Course Objectives

The objective of this course is:

1. To make engineering students aware about Biology as the basic science that facilitate understanding of complex living human machine and its response.
2. To impart knowledge about the common processes in human life science (like respiration, exchange of energy by human cell etc.) and engineering as biologically inspired technologies like bioenergetics, bioprocesses, biomaterials etc.
3. To introduce study of technical topics such as Biosensors, transducers, amplifiers and signal processing, Magnetic resonance imaging, with an objective of appreciating engineering principles in biological systems used for diagnostic tools.

Course Outcomes

Upon the completion of this course students will be able to

1. Understand the basics of biology regarding the life structures and process.
2. Comprehend Biomolecules and Enzymes as basic building block of all forms of life
3. Understand the principles of energy transaction in living systems.
4. Identify DNA as a genetic material in the molecular basis of information transfer
5. Realize generation of bioelectric signals and understand fundaments of Biosensors and devices.

Unit-I

Engineering perspective and analogies of Biological Sciences, Fundamental differences between science and Engineering- case studies; Hierarchy and classification of life forms, Levels of organization of life- cell, tissues, organs, system and organism, Anatomy and physiology.

Unit-II

Biomolecules and Enzymes : Biomolecules as basic building block of all forms of life, structure and function of carbohydrates, proteins and Amino acids, Lipids, Nucleic acids, Vitamins and Minerals, Enzymology- Introduction, classification and mechanism of action.

Unit-III

Metabolism /Bioenergetics : Fundamental principles of energy transactions (Thermodynamics) as applied to biology, Entropy changes in biological systems, free energy, equilibrium, process of synthesis and breakdown of glucose in human body.

Unit-IV

Genetics : Introduction to Genetics, genetic codes, Expression and Transmission of genetic Information, concept of DNA cloning, single gene disorders in humans.

Unit-V

Bioelectric signals and devices : Resting and action potential, propagation of bioelectric signals, various bioelectric signals- ECG, EEG, EMG. Human nervous system as complex electric network.

Unit-VI

Biosensors : Introduction to Biosensors, transducers, amplifiers.

Overview of Bio Imaging-Brief introduction to medical imaging and different medical Imaging modalities; Electro Physiological Signal Analysis. Diagnostic Devices- Overview of Radiography, Nuclear Medical Imaging, Magnetic Resonance Imaging, Ultrasound Imaging. Therapeutic Devices- Overview of Diagnostic application of LASERs, High frequency heat therapy, Automatic Drug delivery Systems.

Text Book

1. Biology: A Global Approach: Campbell, N.A.;Reece, J.B;Urry,Lisa; Cain,M,L; Wasserman, S.A.; Minorsky, P.V.; Jackson, R.B.Pearson Education Ltd.
2. Eggins BR. (1006) Biosensors: An Introduction. John Wiley & Sons Publishers.
3. Biology for Engineers, SOHONI SINGH, Vayu Education, ISBN 9789383758265
4. Biology for Engineers ,Wiley India, Wiley Editorial, ISBN 9788126576340

Reference Books

1. Molecular Cell Biology. W.H.Freeman.: Lodish H, Berk A, Zipursky SL, et al. (2000)
2. Principles of Biochemistry.: Lehninger, A.L., Nelson, D.L., & Cox, M.M (2000). Newyork; Worth Publishers
3. Genes VII: Lewin B.(2000). Oxford University Press.th
4. Medical Instrumentation Application and Design :John G. Webster, ,4 edition, Wiley India,2015
5. Biology for Engineers by G. K. Suraish kumar, Oxford University Press, 1st Ed.

VI Semester
Department of Electrical Engineering

Course Code : EET374-5 **Course : Photovoltaic System Engineering**

L: 2 Hrs., T: 0 Hrs., P: 1 Hrs. per week **Total Credits : 03**

Course Objectives

1. To introduce solar insolation, equivalent circuit of solar Photovoltaic(PV) cell and the factors affecting PV power generation.
2. To introduce the concept of maximum power point (MPP) and algorithms used to track the MPP.
3. To introduce power electronics required in PV system.
4. To introduce the various applications of PV system.

Course Outcomes

On the completion of this course, Students will be able to:

1. Calculate the average monthly solar insolation from given data.
2. Understand circuit model of PV cell and interpret I-V curves under different operating conditions.
3. Understand the algorithms used for the maximum power point tracking of PV array.
4. Understand the principle of power conversions used in PV system
5. Design PV system by estimating the load, sizing and selecting the batteries, sizing and selecting the PV modules and other components
6. Understand the various applications of PV systems.

Unit - I

Introduction : Fossil fuel energy usage and global warming; role of renewable energy in sustainable development; renewable energy sources; global potential for solar electrical energy systems.

Unit - II

Solar radiation : Extra-terrestrial and terrestrial solar spectrum; clear sky direct-beam radiation; total clear sky insulation on a collecting surface; radiation on the collector in tracking systems; calculation of average monthly insolation from measured data.

Unit - III

PV cells and modules : Photovoltaic cell and its simple model; i-v and p-v characteristics; PV modules and arrays; effect of shading, use of bypass and blocking diodes; influence of temperature; types of solar cells and their performance; schemes for maximum power point tracking;

Unit - IV

Maximum Power Point Tracking : Maximum Power Point Tracking and MPPT algorithms

Unit - V

Power converters in Photovoltaic system : Introduction to DC-DC converter, DC-AC Converter, PV-Grid Interface

Unit - VI

PV system applications : PV-Battery Interface, PV and Water Pumping,

Text Book

1. Solar Photovoltaic: Fundamentals, Technologies and Applications: Solanki, PHI Learning Pvt Ltd, 2009

Reference Books

1. Renewable and Efficient Electric Power Systems: Gilbert M. Masters, John Wiley & Sons, 2004
2. Photovoltaic Systems Engineering: Roger A. Messenger & Jerry Ventre, CRC Press, 2004, 2nd edition.

Experiments based on above syllabus

1. To measure the open circuit voltage and short circuit current of given panel.
2. Series and Parallel Connection of PV Panels
3. Effect of Tilt angle, Temperature on PV power.
4. Effect of Shading on PV panel
5. Maximum power point tracking
6. PV simulation using open source software
7. Introduction to Power converters in PV system
8. Photovoltaic based Battery charging
9. Photovoltaic based water Pumping

VI Semester
Department of Electrical Engineering

Course Code : EEP376 **Course : E-Circuit Design and Testing Lab**

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

Course Objectives

The objective of this laboratory course is to provide hands on exposure to the students to conceptualize, design, fabricate and testing of simple electrical and electronic circuits.

Course Outcomes

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

1. Understand the various ratings of electrical and electronics components.
2. Analyse the performance of electrical and electronics circuits.
3. Synthesize the electrical and electronics circuits individually or as a Team.
4. Test the electrical and electronics circuits and summaries the test results.

References

1. E Component Manufacturers Data Sheets
2. E Component Manufacturers Application notes
3. Online resources available
4. Online technical discussion forums

VI Semester
Department of Electrical Engineering

Course Code : EEP377 **Course : Comprehensive Viva**

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

Course Objectives

The objective of this course is to prepare students to achieve success in the placement process and competitive exams for higher studies, by encouraging them to revise the core subjects in Electrical Engineering and provide practice for technical interview.

Course Outcomes

Upon completion of the course students must be able to;

1. Solve MCQ based on the syllabus with reasonable accuracy and speed.
2. Face the technical interview based on the syllabus fairly.

Following subjects form the basis for implementation of this syllabus:

1. III - Network Analysis
2. III - Analog Electronics
3. III - Electrical Measurements & Measuring Instruments
4. IV - Signals & Systems
5. IV - Digital & Linear Electronics Circuits
6. IV - Electrical Machines-I
7. IV - Power Electronics
8. IV - Electromagnetic Fields
9. V - Microprocessor
10. V - Power System-I
11. V - Electrical Machines-II

Proposed Syllabus : As per the subjects mentioned above.

Text Books

Books of the subjects mentioned above and books published every year for GATE examination preparation with solved papers.

VI Semester
Department of Electrical Engineering

Course Code : EET399 - 1 **Course : Solar Photovoltaic Systems**

L: 3 Hrs, T: 0 Hr, P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

Objectives of this course are to make the student aware about potential of solar photovoltaic energy source, introduce modeling of PV cell, understand the maximum PV power harnessing and familiarize with PV power conversion devices.

Course Outcomes

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

1. Calculate and analyse solar insolation on a collecting surface by locating the sun position at any given location and time, interpret sun path diagrams.
2. Interpret I-V curves from the circuit model of a PV cell, understand the impact of temperature and solar insolation on I-V curves.
3. Evaluate the algorithms used for the maximum power point tracking of PV array.
4. Understand the principle of DC-AC power conversion in Grid connected PV system
5. Design standalone PV system by estimating the load, sizing and selecting the batteries, sizing and selecting the PV modules and other components
6. Understand the various issues in PV systems.

Unit I

Introduction : Fossil fuel energy usage and global warming; role of renewable energy in sustainable development; renewable energy sources; global potential for solar electrical energy systems.

Unit II

Solar Radiation : Extra-terrestrial and terrestrial solar spectrum; clear sky direct-beam radiation; total clear sky Insolation on a collecting surface; radiation on the collector in tracking systems; calculation of average monthly insolation from measured data.

Unit III

PV Cells and Modules : Photovoltaic cell and its simple model; i-v and p-v characteristics; PV modules and arrays ; effect of shading, use of bypass and blocking diodes; influence of temperature; types of solar cells and their performance; Charge controller, Introduction of maximum power point tracking algorithms.

Unit IV

PV Inverters : Principle of DC-AC conversion, Working of Grid-connected PV inverter, schemes and basic control; Introduction to Grid Interfacing standards.

Unit V

PV Systems with Battery Energy Storage : Power processing schemes and control for stand-alone applications; batteries for energy storage – types, charging, battery sizing and turn-around efficiency; other types of energy storage for PV systems; grid connected schemes with standby energy storage.

Unit VI

System Level Issues : Design related issues; grounding, dc arcing and other safety related issues; islanding; harmonics; electro-magnetic interference; energy yield and economics of a PV installation.

Text Books

1. Solar Photovoltaic: Fundamentals, Technologies and Applications: Solanki, PHI Learning Pvt Ltd, 2009

Reference Books

1. Photovoltaic Systems Engineering: Roger A. Messenger & Jerry Ventre, CRC Press, 2004, 2nd edition.
2. Renewable and Efficient Electric Power Systems: Gilbert M. Masters, John Wiley & Sons, 2004

VI Semester
Department of Electrical Engineering

Course Code : EET399 - 2 **Course : Automation with PLC**

L: 3 Hrs, T: 0 Hr, P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

An objective of this course is to introduce the basics of Automation, its components and controls to the students. Students will be made familiar with the designing of simple Automatic system.

Course Outcomes

Upon the completion of this course, students will be able to...

1. Understand industrial process involved in the conversion of row material into finish product.
2. Understand automation tools &its components.
3. Understand the components used for measurement of physical parameters like temperature, pressure, speed etc. by using different transducers.
4. Understand the functioning of PLC.
5. Apply knowledge of PLC for design of industrial automation applications.

Unit I

Introduction to Industrial Process : Industrial process, Heating process, bending process, drilling process, painting, galvanizing etc, automatic process, Non automatic process, advantages & disadvantages.

Unit II

Automaton Tools : Block diagram of automatic system, type of controller, Contactor relay timer logic, micro controller, Intelligent devices, PLC, DCS.

Unit III

Components in use Automation : Concept of PCC, MCC, Control desk , No, NC switches, limit switches, relay, relay board, contactor, timer, voltage to current converter, current to voltage converter, solenoid valve, Electrically Hydraulic &pneumatic control, Hydraulic electric power pack, Hydraulic motor control, selection of sensor.

Unit IV

Measurement of Physical Parameters : Linear displacement, angular displacement, temperature , pressure, tension measurement, flow , thickness, coating measurement, linear speed measurement, angular speed measurement (Taco generator & Encoder) , Concept of (AC & DC) drive & soft-starter etc., classification on the basis of output signal.

Unit V

PLC & SCADA : PLC: Introduction to PLC & Its need in automation, block diagram of PLC, I/O modules in PLC, Addressing in I/D modules, Ladder diagram, component of Ladder diagram, Ladder diagram design, Interfacing of component & sensors used in automation, PLC communication (Mod bus communication, Ethernet, RTU.

Unit VI

Application & Design of Automation : Conveyer belt, starting of induction motor, Automation of water management system

Text Books

1. Programmable Logic Controllers: William Bolton (Author),ISBN-13: 978-0750681124 4th Edition

Reference Books

1. PLC Manuals & user guide.

VI Semester
Department of Electrical Engineering

Course Code : EETH61 **Course : Advance Power Electronics**

L: 3 Hrs, T: 1 Hr, P: 0 Hrs. Per week **Total Credits : 04**

Course Objectives

The objective of the course is to prepare the students:

1. To study and compare different power electronics devices as per their applications.
2. To study recent and advanced developments in power electronics area.
3. To study various power converters components.

Course Outcomes

After completion of this course, students shall be able to

1. Select suitable semiconductor switches for various power electronics converters.
2. Design and analyze the operation of multilevel and multiphase converter with their performance parameters, output waveforms, applicability depending on nature of load..
3. Design and analyze the operation of two level and multilevel inverter with their performance parameters, output waveforms, applicability depending on nature of load.
4. Design and classify the harmonics in Inverter and harmonics reduction techniques.
5. Design and analyze the operation of resonant converter with their performance parameters, output waveforms, applicability depending on nature of load.

Unit I

Overview of Power Semiconductor Devices : SCR, TRAIC, BJT, IGBT, MOSFET, GTO, their turn-on and turn-off methods characteristics, protection and their applications.

Unit II

Multilevel and Multiphase Converter : Multiphase converter, multilevel converter, reduced switch converter, harmonics elimination technique.

Unit III

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.

Unit IV

PWM Inverters : Single pulse, Multiple Pulse and Sinusoidal PWM, Trapezoidal, Stepped Harmonic Injection and Delta Modulation, Space Vector PWM, Current Hysteresis Controlled PWM, Harmonic elimination schemes, Dead-time, Snubber and Gate Drive circuit, Multilevel Inverters, Basics of Matrix converter.

Unit V

Resonant Converters : Introduction - Basic resonant circuit concepts - Classification - Load resonant converters - Resonant switch converters - Zero voltage switching clamped voltage converters - Resonant DC link inverters High frequency link integral half cycle converters - Phase modulated resonant converters.

Unit VI

Design of Power Converters Components : Design of magnetic components, design of transformer, Design of Inductor and current transformer, Selection of filter capacitors, Selection of ratings for devices, Input filter design, Thermal design

Text Books

1. Power Electronics: M. Rashid: - Pearson Education India, 2004.
2. Power Electronics: Converters, Applications and Design: N. Mohan and T. M. Undeland, , 2012, John Willey, 3rd Edition
3. Industrial Power Electronics: Deodatta Shingare, Electrotech Publication, Pune,1st Edition
4. Power Electronics: M.D. Singh, K.B. Khanchandani, Tata McGraw Hill.

Reference Books

1. Power Electronics: C.Y. Lander, McGraw Hill International, 1993, 3rd Edition.
2. Principles of Power Electronics: Joseph Vithyathil, Tata McGraw Hill, 2010,1st Edition. 2010
3. Fundamentals of Power Electronics: R. W. Erickson and D. Maksimovic, Springer Science & Business Media, 2007.
4. Power Electronics: Essentials and Applications: L. Umanand, Wiley India, 2009.

VI Semester
Department of Electrical Engineering

Course Code : EETM61 **Course : Renewable Energy Sources**

L: 3 Hrs, T: 1 Hr, P: 0 Hrs. Per week **Total Credits : 04**

Course Objectives

The objective of the course is to prepare the students:

1. To explain the concepts of Non-renewable and renewable energy systems in overall energy scenario.
2. To outline utilization of different renewable energy sources for both domestic and industrial applications
3. To apply and analyze the thermo electric conversion processes for environmental and cost economics of renewable energy sources in comparison with fossil fuels.

Course Outcomes

At the end of this course students will demonstrate the ability to

1. Find ways of power generation by understanding different renewable energy sources
2. Implement the cost economics with the knowledge of operational efficiencies of various energy systems
3. Differentiate the advantages and disadvantages of different renewable energy sources and understand the problems of their design.

Unit I

Global and National Energy Scenario : Over view of conventional & renewable energy sources, need, potential & development of renewable energy sources, types of renewable energy systems, Future of Energy Use, Global and Indian Energy scenario, Energy for sustainable development, renewable electricity and key elements, Global climate change, CO2 reduction potential of renewable energy- concept of Hybrid systems.

Unit II

Solar Energy : Solar energy system, Solar Radiation, Availability, Measurement and Estimation, Solar Thermal Conversion Devices and Storage, Solar-Electrical Power Generation, general Solar Photo Voltaic (SVP) system, Different configurations, SPV system components and their characteristics, Stand-Alone and Grid Connected SPV systems, other Miscellaneous Applications of Solar Energy.

Unit III

Wind Energy : Wind Energy Conversion, Potential, Nature of the wind, Wind Data and Energy Estimation, Site selection, Types of wind turbines, Wind farms, Wind Generation and Control., classification of wind, characteristics, offshore wind energy – Hybrid systems, wind energy potential and installation in India.

Unit IV

Hydel and Tidal Power Systems : Basic working principle, Classification of hydel systems: Large, small, micro – measurement of head and flow – Energy equation – Typesof turbines – Numerical problems. Tidal power – Basics – Kinetic energy equation – Numerical problems – Wave power – Basics – Kinetic energy equation.

Unit V

Bio-Mass, Geothermal& Ocean Energy : Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation and economic aspects.

Geothermal Energy : Resources, types of wells, methods of harnessing the energy, potential in India.

Ocean Energy : OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles

Unit VI

Direct Energy Conversion : Need for DEC, Carnot cycle, limitations, principles of DEC. Thermoelectric generators, seebeck, peltier and joul Thomson effects, Figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD Engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principles, faraday's law's, thermodynamic aspects, selection of fuels and operating conditions

Text Books

1. Solar Energy: Principles of Thermal Collection and Storage: S. P. Sukhatme and J. K. Nayak, TMH, New Delhi, 3rd Edition.
2. Renewable Energy Resources: John Twidell and Tony Weir, Taylor and Francis, 2013, 2nd second edition.
3. Non-Conventional Energy Sources: G.D. Rai, Khanna Publishers

Reference Books

1. Renewable Energy: Godfrey Boyle-oxford university, press, 2013,3rd edition.
2. Handbook of renewable technology: Ahmed and Zobaa, Ramesh C Bansal, World scientific, Singapore.
3. Renewable Energy Technologies: Ramesh & Kumar, Narosa.
4. Renewable energy technologies – A practical guide for beginners: Chetong Singh Solanki, PHI.
5. Non conventional energy source: B.H. Khan- TMH, 2nd edition.
6. Integrated energy systems modeling: Karlsson, Kenneth Bernard, Skytte, Klaus Morthorst, Published in DTU International Energy Report 2015.

VII Semester
Department of Electrical Engineering

Course Code : EET451 | **Course : High Voltage Engineering**

L: 3Hrs, T: 3Hr, P: 0Hrs. Per week | **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. To make students understand the breakdown mechanisms in dielectrics.
2. To make students know about overvoltage phenomenon in the power system, their protection and insulation coordination.
3. To introduce students with the high voltage and high current generation and measurement techniques for testing purpose.
4. To familiarize students with the non destructive and high voltage testing of electrical equipment.

Course Outcomes

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

1. Breakdown mechanisms in dielectrics.
2. Over voltage phenomenon in power system with protection and insulation coordination.
3. Generation & measurement techniques of high voltage and current for testing purpose.
4. Non destructive and high voltage testing of electrical equipments.

Unit - I

Breakdown Mechanism in Dielectrics : Ionization processes in gaseous dielectrics, Townsend's criterion for break-down, break-down in electro-negative gases, time lag for break-down, Streamer theory of break-down in gases, Paschen's law, break-down in non-uniform fields, practical considerations in using gases for insulation purpose; break-down in vacuum; liquid as insulators, conduction and break-down in pure and commercial liquids; break-down in solid dielectrics; break-down in composite dielectrics.

Unit - II

Lightning and Switching Over Voltages : Lightning mechanism, types of lightning strokes, parameter and characteristics of lightning strokes, protection of power system against lightning over voltages, types of lightning arresters, surge absorbers; types of switching over voltages and their causes, protection against switching over voltages; Insulation coordination, BIL and SIL.

Unit - III

Generation of High Voltage and Currents : Generation of high D.C. voltage by rectifier, voltage doublers and multiplier circuit, generation of high AC voltage by cascade transformers, resonant transformer; generation of high frequency AC high voltage; impulse waveform, generation of impulse

voltage, tripping and control of impulse generator; generation of switching surges; generation of impulse current.

Unit - IV

Measurement of High Voltage and Current : Measurement of high AC and DC voltages by micro ammeter, generating voltmeters, resistance and capacitance potential divider, series impedance voltmeter, CVT, magnetic type potential transformers, electrostatic voltmeter, peak reading AC voltmeters, sphere gap arrangement; measurement of impulse voltage by potential dividers and peak reading voltmeters; measurement of high AC, DC and impulse currents.

Unit - V

Non-destructive Testing : Significance of non-destructive testing, measurement of DC resistivity, measurement of dielectric constant and loss-factor, partial discharge phenomenon and measurement, discharge detection in power cables.

Unit - VI

High Voltage Testing of Electrical Apparatus : Various standards for HV Testing of electrical apparatus, IS, IEC standards, Testing of insulators, bushings, isolators, circuit breakers, cables, transformers, lightning arresters and power capacitors.

Text Books

1. High Voltage Engineering: M. S. Naidu & V. Kama Raju, Tata McGraw Hill Publication.
2. High Voltage Engineering: C. L. Wadhawa, New Age international (P) Ltd Publisher.
3. High Voltage and Electrical Insulation Engineering: Ravindra Arora & Wolfgang Mosch Wiley-IEEE Press.
4. High Voltage Engineering: M. P. Chaurasiya, Khanna Publisher.

Reference Books

1. Fundamentals of High Voltage Engineering: S. K. Singh, Dhanpatrai & Co.
2. High Voltage Engineering Fundamentals: KuffelE ., Butterworth-Heineman, 2000.
3. Various IS standards for HV Laboratory Techniques and Testings.

VII Semester
Department of Electrical Engineering

Course Code : EEP451 **Course : High Voltage Engineering Lab**

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

Course Objectives

The objective of the course is to prepare the students:

1. To familiarize the students with different types of high voltage generation and measurement techniques.
2. To demonstrate the breakdown mechanisms in different types of dielectrics and with different electrode geometries.
3. To introduce the students with different types of over voltages in power system and with their protection.
4. To familiarize students with non-destructive and high voltage testing.

Course Outcomes

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

1. Students shall be able to apply, analyze and co-relate fundamental principles of science & Engineering with laboratory experimental work.
2. Students shall be able to understand and connect the circuit to perform the experiment, analyze the observed data & make valid conclusions.
3. Students shall be able to understand & write Journal with effective presentation of diagrams, characteristics and graphs.
4. Students shall be able to understand the use of modern tools in the High voltage Engineering Lab.

Proposed Syllabus: Students need to perform 10 to 12 practicals based on the theory course of High Voltage Engineering.

VII Semester
Department of Electrical Engineering

Course Code : EET452-1 **Course : Advanced Electric Drives and Vehicles**

L: 3Hrs, T: 0Hr, P: 0Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. To introduce with the operation and performance of DC and AC Drives.
2. To make understand various control techniques used in the control of the machines.
3. To familiarize with the different topologies of Electric vehicle with its control.

Course Outcomes

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

1. Select proper power electronic converter to control speed of D.C. motor, 3 phase Induction motor, Synchronous motor and select controlling parameter depending on the application of motor.
2. Compare the electric and non-electric traction system with conventional methods of operation of traction system.
3. Understand the basics of electric vehicle with advanced motor drives.

Unit - I

DC Motor Drives : Dynamics of electric drives and control of electric drives, Introduction of D.C. Motor drives, controlled rectifier fed D.C. Drives, single phase and three phase rectifier control of D.C. separately excited motor. Dual converter control of D.C. separately excited motor. Power factor supply harmonics and ripple in motor current. Chopper controlled DC drives of separately excited DC motor chopper control of series motor, source current harmonics.

Unit - II

Induction Motor Drives : Introduction of Induction motor drives, stator voltage control, variable frequency control using voltage source inverter, current source inverter & cycloconverter. 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. Introduction to vector control of induction motor.

Unit - III

Synchronous Motor Drives : Introduction of Synchronous Motor Drives, starting, braking of synchronous motor, variable frequency control, self-controlled synchronous motor drive employing load commutated Thyristor inverter or cycloconverter, starting of large synchronous motors.

Unit - IV

Traction Drives : Conventional D.C. and A.C. traction drives, semiconductors converter controlled Drives, 25KV AC Traction using semiconductor converter controlled DC Motor. DC Traction using semiconductor, chopper controlled DC motors

Unit - V

Electric Vehicles : History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, Basics of vehicle performance mathematical models to describe vehicle Performance, electrical loads in vehicle, Introduction to various electric drive train topologies, power flow control in electric drive-train topologies, Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles

Unit - VI

Advanced Motor Drives : Brushless DC motor drive, switched reluctance motor drives, permanent magnet synchronous motor drive.

Text Books

1. Fundamentals of electric drives: G. K. Dubey.
2. Modern Electric Traction: H. Pratap.
3. Electric drives concepts and applications: V. Subramanan.

Reference Books

1. Electrical Drives: Jon Boldea, N.A. Nasar
2. Electrical Drives Control: R. Krishnan
3. Electrical Machines and Drives: Ned Mohan
4. Analysis of Electric Machinery, Krause P. C. TMH, New Delhi, Latest Edn.

VII Semester
Department of Electrical Engineering

Course Code : EET452-2 **Course : Computer Application in Power System**

L: 3Hrs, T: 0Hr, P: 0Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. Huge Electrical integrated power system networks are represented with single line Diagrams sections , therefore objective is to learn these by using Graph Theory so as to enable to form various incidence and network matrices in different frames of reference like Bus , branch and loop equations.
2. To explore the algorithm to be used for formation of Bus Impedance and Bus Admittance Matrices as an ingredients for short circuit and Load flow analysis respectively by representing in Three phase networks and various standard Numerical methods.
3. The transient stability analysis to be learned with the prospective of observing behavior of single machine and its power angle using swing equation. Learning of solution to differential equations by Numerical methods as applied to transient stability are imperative.
4. Learning required language for writing suitable computer programs for achieving all above objectives.

Course Outcomes

At the end of this course students will demonstrate the ability to

1. The students should describe the Graph theory and should be able to Form single phase Incidence and Network Matrices.
2. The students should be acquainted to Form Bus Impedance and Bus Admittance Matrices using Algorithm and they should understand the steps for simulating the construction of Network by adding one element at a time.
3. The students should be able to describe three phase representation of networks, transformation Matrix, symmetrical components along with formation of Incidence matrices.Tthey should also be able to form only three phase Bus Incidence Matrix using algorithm.
4. The student should be geared with Ability to determine power flows and system voltages during normal and emergency conditions. They should be able to draw flow charts for Numerical solution to linear and nonlinear algebraic equations.
5. The students should be able to understand any symmetrical / unsymmetrical faults for a chosen power system Network at any location for complete analysis under short circuit conditions. They should understand the flow charts for achieving this task.
6. The student should able to describe the solution of swing equation / differential equations employed in Transient stability studies.

Unit - I

Incidence and Network Matrices : Graph Theory, Incidence Matrices, Primitive network, formation of network, matrices by Singular transformations.

Unit - II

Z Bus using Algorithm : Algorithm for formation of Bus Impedance and Bus Admittance matrix for system without mutual coupling.

Unit - III

Three Phase Networks : Three phase balance network elements with balanced and unbalanced excitation, Incidence and network matrices for three phase element.

Unit - IV

Load Flow Studies : Power system load flow equations, solution technique Gauss Seidel, Newton Raphson and fast decoupled technique without voltage control buses, Elementary flow charts.

Unit - V

Short circuit studies : Three phase network short circuit calculations using bus impendence matrix for balanced and unbalanced faults.

Unit - VI

Transient Stability Studies : Modeling of synchronous machine, power system network for transient stability studies, Numerical solution of swing equation using Modified Euler and Rungekutta 4th order method. Elementary flow charts for the transient stability study

Text Books

1. Computer Methods in Power System Analysis: Stagg and El-Abiad, Mc-Graw Hill Kogakusha, Ltd

Reference Books

1. Power System Analysis and Stability: S N Sivanandan, S N Deepa, J Rizwana, Vikas Publishing House PVT LTD.
2. Computer Aided Power system Operation and Analysis: R.N. Dhar, McGraw Hill

VII Semester
Department of Electrical Engineering

Course Code : EET452-3 **Course : Advanced Control Systems**

L: 3Hrs, T: 0Hr, P: 0Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. Introduce to the student's basics of state variable approach and feedback design problems and also to introduce concept of Optimal Control theory.
2. To introduce the students to basics of digital control system, its representation in state space model and stability investigation.
3. Students will be able to design controllers to achieve desired specification.
4. Impart the knowledge of different non-linearities present in physical system and its stability analysis.

Course Outcomes

Upon the completion of this course, student will be able to:

1. Analyze continuous time system using state space technique and investigate Controllability and Observability of the system.
2. Design control system using the pole placement technique.
3. Understand minimization of function using calculus of variation.
4. Analyze digital systems using the Z-transformation.
5. Analyze nonlinear system using the describing function technique and phase plane analysis.

Module - I

State Variable Analysis : Review of state variable representation, Solution of state equation, State Transition Matrix, Controllability, Observability, Principal of Duality.

Module - II

State Variable Design : Introduction, Pole Placement problem, Design of Servo Systems, State Observers, Design of Control System with Observers.

Module - III

Optimal Control System : Introduction, Types of Optimal Control Problem, Basic Concepts of Calculus of Variation, Finding Minima of function, Linear Quadratic Regulator(LQR) Problem.

Module - IV

Discrete Control System : Basics of Digital Control Systems. Discrete representation of continuous systems, Sample and hold circuit, Z-Transform and Inverse Z Transform for analyzing discrete time systems, Pulse Transfer function. Pulse transfer function of closed loop systems, Mapping from s-plane to z plane, Solution of Discrete time systems, Time response of discrete time system. Stability by bilinear transformation & Jury's test.

Module - V

Describing Function Analysis of Nonlinear Control System : Introduction to Nonlinear Systems, Describing Functions for Common Types of Nonlinearities, Describing Function Analysis, Stability and Limit Cycles

Module - VI

Phase Plane Analysis : Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase-plane analysis of nonlinear control systems.

Text Books

1. Control Systems- Principles and Design: M. Gopal, McGraw Hill Education, 1997.
2. Modern Control Engineering: K. Ogata, Prentice Hall, 1991.
3. Control Systems Engineering: I. J. Nagrath and M. Gopal, New Age International, 2009
4. Digital Control Engineering: M. Gopal, Wiley Eastern, 1988.

Reference Books

1. Digital Control and State Variable Methods: M.Gopal
2. Digital Control Engineering: K. Ogata, Prentice Hall, Englewood Cliffs, 1995.
3. Optimal control theory; an Introduction: Donald E.Kirk by Dover publications.
4. Nonlinear Systems- Analysis, Stability, and Control: S. Sastry, Springer
5. Linear System Control Deterministic and Stochastic Methods: Elbert Hendricks, Ole Jannerup, Paul Haase Sorensen.

VII Semester
Department of Electrical Engineering

Course Code : EET452-4 **Course : EHVAC Transmission Systems**

L: 3Hrs, T: 0Hr, P: 0Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. To provide in-depth understanding of different aspects of Extra High Voltage AC transmission system design and analysis.
2. To determine the interference caused by Corona andto measure its magnitude.
3. To provide the knowledge about use of circuit breakers in EHV lines.

Course Outcomes

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

1. Calculate the power handling capacity and surface voltage gradient of EHVAC transmission system.
2. Analyze the effect of corona, electrostatic field of EHVAC lines.
3. Analyze the use of circuit breakers in EHV lines.

Unit - I

EHV ac transmission lines : Need for EHV transmission lines, Power handling capacity and line loss, Examples on giant power pools and number of lines, Mechanical considerations in line performance, Vibrations Travelling wave equations, transmission reflection attenuation and distortion of travelling waves, transmission and reflection coefficients and examples.

Unit - II

Calculation of line and ground parameters : Resistance of conductors, effect of temperature on overhead conductors, temperature rise of conductors and current carrying capacity, Properties of bundled conductors, Inductance of current carrying single conductor, Inductance of EHV line configurations, Line capacitance calculations. Sequence inductances and capacitances, diagonalization

Unit - III

Voltage Gradient of Conductors : Electrostatic Field of a point charge and its properties, Field of sphere gap, Field of line charges and their properties, Corona inception gradients, charge potential relations for multi-conductor lines, Maximum charge condition on three phase line. Surface voltage gradient on conductors-single conductor, two conductors and multi-conductor bundle, Maximum surface voltage gradient, Mangoldt formula, design of cylindrical cage for corona gradients

Unit - IV

Corona and its Effects : Corona formation, corona inception voltage, visual corona voltage, critical field for corona inception and for visual corona under standard operating condition and conditions other than standard operating conditions. Power loss due to corona, corona loss formulae, corona current waveform, charge-voltage diagram and corona loss, increase in effective radius of conductor and coupling factors, attenuation of travelling waves due to corona loss. Audible noise operation and characteristics limits for audible noise, AN measurement and meters, microphone, weighting networks. Formulae for audible noise and use in design, relation between single phase and three phase AN levels. Design of cylindrical cages for corona experiments-single conductor concentric with cylinder, single conductor with eccentricity.

Unit - V

Arc Interruption Phenomenon in Circuit Breakers : Initiation, sustenance and interruption of arcs, Active recovery voltage, RRRV, Current chopping, capacitor switching transients, duties of switchgear.

Unit - VI

Circuit Breakers : SF6 circuit breakers: Arc interruption in SF6 Gas, Construction, operation, ratings, selection and testing of SF6 circuit breakers.

Text Books

1. EHV AC Transmission Engineering: Rakosh Das Begamudre, 4th Edition, New Age International Pvt. Ltd.
2. EHV-AC and HVDC Transmission and Distribution Engineering: S. Rao, Khanna Publications
3. Switchgear & Protection: Badri ram
4. Switchgear & protection: Ravindranath, Chander

Reference Books

1. EHV-AC Transmission Engineering: Sanjay Kumar Sharma, S.K. Kataria & Sons Publishing, 2013
2. NPTEL /online lectures

VII Semester
Department of Electrical Engineering

Course Code : EET452-6 **Course : Electrical Vehicle and Energy Storage System**

L: 2Hrs, T: 0Hr, P: 0Hrs. Per week **Total Credits : 03**

Course Objectives

1. To introduce with the Electric Vehicle
2. To make understand various electric vehicle motors and power converter.
3. To familiarize with the different energy storage devices and its energy management system.

Course Outcomes

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

1. Understand the electric vehicle performance with various drive train topologies
2. Compare the electric vehicle motors and power converters.
3. Comment on various energy storage devices and its management strategies

Unit - I : (06)

Electric Vehicles : History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, Basics of vehicle performance mathematical models to describe vehicle Performance, electrical loads in vehicle, Introduction to various electric drive train topologies, power flow control in electric drive-train topologies

Unit - II : (06)

Electric Vehicle Motors : Configuration and control of Switched reluctance motor (SRM), permanent magnet synchronous motor, brushless dc motor, Comparison efficiency map.

Unit - III : (06)

Power Electronics for Electric Vehicle : Power Electronic Converter for Battery, Charging Charging methods for battery, Termination methods, charging from grid, The Z-converter, Isolated bidirectional DC-DC converter, Design of Z converter for battery charging, High-frequency transformer based isolated charger topology, Transformer less topology

Unit - IV : (06)

Energy Storage : Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

Unit - V : (06)

Energy Management Strategies : Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Text Books

1. Vehicular Electric Power Systems-Land, Sea, Air and Space Vehicles: 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: Kwang Hee Nam, CRC Press, Special Indian Edn, (Yes Dee Publishing Pvt. Ltd, Chennai) 2013.
3. Electric Vehicle Battery Systems: Sandeep Dhameja, Elsevier India Pvt. Ltd, 2013.

Reference Books

1. Recent IEEE papers 2. NPTEL courses

Experiments based on above syllabus

1. Speed Control of Motors
2. Power Converters
3. Charging and Discharging of Battery and Fuel Cells

VII Semester
Department of Electrical Engineering

Course Code : EET498-1 **Course : Electrical Vehicle**

L: 3Hrs, T: 0Hr, P: 0Hrs. Per week **Total Credits : 03**

Course Objectives

The course focuses on architecture and component of EV based on the requirements to power flow management, power conversion and thus to vehicle dynamics and energy/fuel efficiency.

Course Outcomes

At the end of this course students will demonstrate the ability to

1. Understand the models to describe hybrid vehicles and their performance.
2. Understand the different possible ways of energy storage.
3. Understand the different strategies related to energy storage systems.

Unit - I

Introduction : Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

Unit - II

Hybrid and Electric Vehicle : Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Unit - III

Electric Trains : Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Unit - IV

Energy Storage : Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

Unit - V

Energy Management Strategies : Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Unit - VI

Case Studies : Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV)

Text Books

1. Hybrid Electric Vehicles - Principles and Applications with Practical Perspectives: C. Mi, M. A. Masrur and D. W. Gao, John Wiley & Sons, 2011.
2. Hybrid Electric Vehicles - Energy Management Strategies: S. Onori, L. Serrao and G. Rizzoni, Springer, 2015.
3. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles - Fundamentals, Theory, and Design: M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, CRC Press, 2004.
4. Electric and Hybrid Vehicles: T. Denton, Routledge, 2016

VII Semester
Department of Electrical Engineering

Course Code : EET498-2 **Course : Industria IoT Instrumentation and Connectivity**

L: 3Hrs, T: 0Hr, P: 0Hrs. Per week **Total Credits : 03**

Course Objectives

Objective of this course is to make the student acquainted with the Instrumentation systems used in Internet of thing (IoT) applications and their interfacing with IoT board. This course also introduces the devices for instrument connectivity.

Course Outcomes

At the end of this course students will demonstrate the ability to

1. Understand the basic blocks and applications of IoT.
2. Select various sensors and transducers required for IoT based Instrumentation
3. Understand different communication protocols used in Industrial IoT Instrumentation system.
4. Understand the interface between IoT system and Programmable logic controllers.

Unit - I

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.

Unit - II

Measurement of Physical Quantities : Temperature Sensor, Humidity Sensor, Pressure sensor. Measurement of Flow: Sensors for Air flow, gas flow, water flow.

Measurement of Motion: Magnetometers, Gyroscopes, Accelerometer, Vibration

Unit - III

Measurement of Occupancy : PIR sensors, Proximity sensors Acoustic sensors, Image sensors, light sensors, RF ID: Active/Passive RF Tags, RFID Reader/ Writer, Smoke sensors, Gas sensors

Unit - IV

Sensors for measurement of voltage, current.Position Sensors: GPS Position, Altitude. Human Machine Interface sensors: Touch Sensors, buttons, sliders

Unit - V

IoT Connectivity : Wireless communication: RF Module, Wi-Fi module, ZIGBEE, Bluetooth Low energy,Wired communication: RS485,Ethernet, MODBUS,PROFIBUS,

Unit - VI : Introduction to PLC

Text Books

1. Transducers and Instrumentation: D.V.S. Murty, PHI Publications
2. Internet of Things: Rajkamak, McGraw Hills Publications
3. Web material

VII Semester
Department of Electrical Engineering

Course Code : MBT451 **Course : Entrepreneurship Development**

L: 3Hrs, T: 0Hr, P: 0Hrs. Per week **Total Credits : 03**

Course Outcomes

1. Qualities and Functions of an Entrepreneur.
2. Business Idea & Plan.
3. Entrepreneurial Development – Agencies.
4. Mobilizing Resources: Entrepreneurial finance.
5. Family business in India E Business & Networking.

UNIT - I

Concept of Entrepreneurship : Meaning, Types, Qualities of an Entrepreneur, Classification of Entrepreneurs, Factors influencing Entrepreneurship, Entrepreneurial Development Programmes (EDP)

UNIT - II

Business Idea & Plan: Sources, Evaluation. Business Plan : Uses, Writing, Data collection. Business Plan Presentation. Government of India Schemes for Entrepreneurs

UNIT - III

Entrepreneurial Development – Agencies : Commercial Banks – District Industries Centre – National Small Industries Corporation – Small Industries Development Organization – Small Industries Service Institute. Business Incubation, Business Clusters

UNIT - IV

Mobilizing Resources : Entrepreneurial finance: Debt, Venture Capital, Buying a Business: challenges, The Search, Process, Scrutiny, Valuation, Negotiation, and Franchising.

UNIT - V

Family business in India : The Founder, The Next Generation, Entry of Family Members, Non-family Managers, Succession, Corporate Social Responsibilities, Corporate Governance, Business Cases, Best Practices

UNIT - VI

E Business & Networking E-Business : Domain Name, Website, E-Commerce, Hosting, Building Traffic Networking: Starting & Managing a Network, Infrastructure, Best Practices Growth Strategies: Stages of Growth, Global Expansion, Relocation, Financing Growth, Business Cases.

Text Books

1. Entrepreneurship, Rajeev Roy Oxford Publication.
2. Entrepreneurship 6th edition. Robert D Hisrich: Tata McGraw-Hill.
3. Kuratko- Entrepreneurship – A Contemporary Approach: Thomson Learning Books
4. Small-Scale Industries and Entrepreneurship: Desai, Vasant Himalaya Publishing House, Delhi. (2003).

Reference Books

1. Business Gurus speaks: Chary, Macmillan
2. Entrepreneurial Development: S.S. Khanka, S. Chand & Co.

VII Semester
Department of Electrical Engineering

Course Code : EEP454 | **Course : Industry Internship Evaluation**

L: 0Hrs, T: 0Hr, P: 2Hrs. Per week | **Total Credits : 00**

Course Objectives

The objective of the course is to prepare the students:

1. To compete internship of minimum six weeks duration (cumulative) in industry/research organization/IIT/IISc/IIIT/NIT/RCoEM during the Winter/Summer vacations prior to the commencement of Semester-VII.
2. To get exposure of real time practices in industry(s) or exposure of research projects in reputed institutes.

Course Outcomes

Upon completion of the course students must be able to;

1. Prepare a report of experience gained in the industry during internship.
2. Give presentation on experience gained in the industry during internship.

Proposed Syllabus

Report and presentation of the training / experience during industry internship.

VII Semester
Department of Electrical Engineering

Course Code : EEP455 **Course : Project Phase - I**

L: 0Hrs, T: 0Hr, P: 6Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. To make students analyze engineering problems by applying knowledge of engineering fundamentals.
2. To familiarize students in designing a system or process, conduct related experiments and interpret the data.
3. To educate students in applying modern engineering and software tools and prepare them to adapt to new technological changes in solving engineering problems.
4. To incorporate professional skills required for timely completion of a given task, to work in result oriented direction individually and in a group for a sustainable solution.
5. To prepare students in communicating effectively on subject matter and writing effective project report.

Course Outcomes

Upon completion of this course students must be able to;

1. Analyze engineering problems by applying knowledge of engineering fundamentals.
2. Design a system or process, conduct related experiments and interpret required data
3. Apply modern engineering and software tools.
4. Acquire professional skills required for timely completion of given task.
5. Communicate effectively on subject matter and write effective project report with presentation.
6. Acquire skills to work in a result oriented direction individually and in group for sustainable solution and be ready to adopt new technological changes to solve engineering problems.

VII Semester
Department of Electrical Engineering

Course Code : EETH71 **Course : Mathematical Methods and Techniques in Signal Processing**

L: 4Hrs, T: 0Hr, P: 0Hrs. Per week

Total Credits : 04

Course Objectives

The objective of the course is to prepare the students:

1. To make aware with the different types of signals and systems with their geometry.
2. To make understand the multirate systems for digital filters.
3. To introduce with different transform in advanced signal processing.

Course Outcomes

At the end of this course students will demonstrate the ability to

1. Represent signals mathematically in continuous and discrete-time.
2. Understand the concept of signal geometry.
3. Understand the concept of sampling and multirate systems
4. Represent digital filters banks.
5. Apply different transform for a particular application

Unit - I

Review of signals and systems : Introduction of signal processing, Review of 1-D signals and systems, review of random signals, multi-dimensional signals, linear time-invariant systems, modes in linear system, introduction to state space representation

Unit - II

Signal Geometry : Introduction to vector spaces, inner product spaces, orthogonal projections, linear independence of orthogonal vectors, linear approximation of signal space, basics of probability and random variables, mean and variance of random variable, random process.

Unit - III

Sampling and Multirate Systems : Sampling theorem, basics of multirate systems, decimation and interpolation, sampling rate conversion (integer and rational sampling rates), over sampled processing (A/D and D/A conversion)

Unit - IV

Digital Filter Banks : Introduction to digital filter banks, DFT as filter bank, efficient architectures for interpolation and decimation filters, multistage filter design, two channel filter bank, M channel filter banks.

Unit - V

Wavelets : Introduction to wavelets, multiresolution analysis and properties, the Haar wavelet, wavelet reconstruction, wavelet link to filter banks, circular convolution.

Unit - VI

Fourier series and KL Transform : Review of Fourier series, convergence of sequence of functions, convergence of Fourier series at a point of continuity, convergence of Fourier series for piecewise differentiable periodic functions, convergence in norm of Fourier series, KL Transform, application of KL transform. Signal Modeling: Least squares technique, Pade approximation

Text Books

1. Mathematical Methods and Algorithms for Signal Processing: Moon &Stirling, Prentice Hall, 2000.
2. Multirate systems and Filter Banks: P. P. Vaidyanathan, Prentice Hall, 2000.

Reference Books

1. A First Course in Wavelets with Fourier Analysis: A. Boggess& F. J. Narcowich, Prentice Hall, 2001.
2. Introduction to Linear Algebra: G. Strang, 2016.
3. Probability and Random Processes with Applications to Signal Processing: H. Stark & J. W. Woods, 2014.

VII Semester
Department of Electrical Engineering

Course Code : EETM71 **Course : Power System**

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

Course Objectives

The objective of the course is to prepare the students:

1. To introduce the students to the general structure of Power System from generating stations to the consumer.
2. To expose the students to different electrical and mechanical aspects of Power System.
3. To familiarize the students with tariff method for electric energy consumption.

Course Outcomes

At the end of this course, student will be able to

1. Understand basic concepts of power system.
2. Determine different electrical and mechanical parameters of overhead transmission lines.
3. Analyse the performance of transmission line.
4. Evaluate different parameters of AC and DC distributor and underground cable.
5. Understand and calculate tariff methods for electric energy consumption.

Unit - I

Introduction : General Structure of Electrical Power System-Introduction to Power System, Generation, Transmission, Distribution and Utilization- Overview Single Line Diagram (SLD) Representation., Idea About Substation and Equipment in Substation, Overhead vs. underground systems, Comparison of AC and DC systems and choice of working voltages for transmission and distribution.

Unit - II

Electrical Design of Overhead Lines : Conductors, types of conductors in use, bundled conductor, spacing of conductors, symmetrical and unsymmetrical spacing, equivalent spacing, transposition, transmission line constants, calculation of resistance, inductance and capacitance for simple arrangements and multi-circuit lines, symmetrical and unsymmetrical spacing, concept of self GMD, mutual GMD and their uses in calculations of parameters of overhead lines, skin and proximity effects.

Unit - III

Characteristics and Performance of Power Transmission Lines : Short and medium transmission lines, Line performance, effect of capacitance, charging currents, short and medium lines, calculation

by nominal-T and nominal-π method, regulation and efficiency, Concept of ABCD constants, the long transmission line-rigorous solution, surge impedance and surge impedance loading, Ferranti effect.

Unit - IV

Mechanical Aspects of Overhead Lines : Main components of overhead lines, conductor materials, line supports, insulators, types of insulators, potential distribution over suspension insulators, string efficiency, methods of improving string efficiency, corona, factors affecting corona, important terms, advantages and disadvantages of corona, sag in overhead lines and sag calculations.

Unit - V

Distribution System and Cables : Types of distribution system and its topologies, Feeders, distributors and service mains, Quantitative analysis of DC and AC distributor.

Types of Cables, Calculation of Capacitance of single-phase and three-phase Cable, Grading of Cable, Power Factor and Heating of Cable.

Unit - VI

Economic Aspects of Power System : Cost of Generation and Tariff, Power factor and its effect on system economy, Power factor improvement

Text Books

1. Modern Power System Analysis: D. P. Kothari and I. J. Nagrath, McGraw Hill Education, 2003
2. Electric Power Systems: C. L. Wadhwa, Wiley Eastern Ltd, New Delhi.
3. Principles of Power System: V. K. Mehta, S. Chand ,2005

Reference Books

1. Power System Analysis: J. Grainger and W. D. Stevenson, McGraw Hill Education, 1994.
2. Electric Energy Systems Theory: O. I. Elgerd, McGraw Hill Education, 1995.
3. Power System Analysis: R. Bergen and V. Vittal, Pearson Education Inc., 1999.
4. Electric Power Systems: M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, Wiley, 2012.

VIII Semester
Department of Electrical Engineering

Course Code : EET472-2 **Course : EHV Substation Design and Erection**

L: 3Hrs, T: 0Hr, P: 0Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. To provide general concept of various EHV substation system.
2. To provide a practical understanding of planning, design, testing and application aspects of EHV substations for utility networks and industrial plants.

Course Outcomes

At the end of this course students will demonstrate the ability to

1. Understand category and utility of substation on the basis of different parameter and classify the substation.
2. Analyse the importance of different components in substation by understanding the basics of different equipment parameter and
3. Design of substation by basic layout and understand system procedure for design of different components/equipments in substation.
4. Understand application of Gas Insulated Substations and planning-commissioning aspects of Substation installation.

Unit - I

Introduction to EHV Substation : Electrical substation – General concept as referred to function, layout, voltage levels, Classification of substation on basis of configuration, Indoor and Outdoor, Application, features and necessity, Concept of EHV-AC and HVDC substation, Single line diagram.

Unit - II

EHV Substation Equipments : Introduction to EHV substation equipments like Bus bars, circuit breakers, power transformers, CT & PTs, Isolators and earth switches, lightening arrestors.

Unit - III

Busbar Layouts/Schemes : General specifications of substation, Bus bar system, bays and layout of EHV substation, Introduction to EHV Transmission Towers – Single & Double Circuit, Types, Configuration.

Unit - IV

Aspects of Substation Design : Principle of substation design, Terms and definitions, Stresses on equipments, all clearances, maintenance zones. All types of substation structures, Dimensions of structures. Preparation of layout drawing using AutoCAD or other tools.

Unit - V

Busbar Design and Substation Earthing : Design concepts of substation bus bar system, material for bus bar, current carrying capacity, Insulation requirements, clearance. Different insulators used in substation, Design aspects of substation Earthing system, Auxiliary supplies required in substation, control and automation in EHV substations.

Unit - VI

GIS and Testing of Equipments : Gas Insulated Substations (>33 kV) – Introduction, Applications, Configuration Advantages and Demerits, Gas insulated cables and their applications, Concept of power line carrier communication, Planning for installation, commissioning and testing of all equipments in EHV substation, technical and commercial feasibility.

Text Books

1. Electrical Substation Engineering and Practice: S. R. Rao, Khanna Publisher

Reference Books

1. Electrical Transmission &Distribution Ref. book: Westinghouse, USA.

VIII Semester
Department of Electrical Engineering

Course Code : EET472-3 **Course : Mechatronics**

L: 3Hrs, T: 0Hr, P: 0Hrs. Per week **Total Credits : 03**

Course Objectives

Objective of this interdisciplinary course is to introduce the basics of mechatronics systems, its components and controls to the students. Students will be made familiar with the designing of simple mechatronics systems.

Course Outcomes

At the end of this course students will demonstrate the ability to

1. Understand the concept and application of Mechatronics.
2. Interface proper sensor and transducer.
3. Select proper Actuator and calculate its power consumption.
4. Identify Hydraulic systems & Pneumatics system required in Mechatronics.
5. Select proper control logic for any Mechatronics based system.
6. Design simple Mechatronics based system for given application.

Unit - I : Introduction to Mechatronics, Applications of mechatronics, Components of Mechatronics, Need of Mechatronics in industries, Objectives, Advantages and disadvantages of Mechatronics.

Unit - II : Introduction to Sensors and Transducers, Digital sensors, Analog sensors, brief study of different sensors and its interfacing with controllers, Brief study of control Relay board, contactor, timer.

Unit - III : Concepts of electrical Actuator, criteria for selection of actuator, classification of actuators , brief study of DC motor, AC motor, stepper motor, BLDC motor, Servo motor, linear actuator with is control technique, Power calculation.

Unit - IV : Concept of Hydraulic systems&Pneumatics system, pressure and direction control valves, mechanical Actuators, and supporting elements, hydraulic power packs, hydraulic pumps, Concept of hydraulic &Pneumatics circuits.

Unit - V : Concept of wire control, concept of programmable controller, PID controller, On-OFF controller.

Unit - VI : Case study of Mechatronics base System,like Door management system, Automatic Washing Machine, Pick and Place robot.

Text Books

1. Mechatronics - Electronic Control Systems in Mechanical and Electrical Engineering: Boltan, W., Longman, Singapore, 1999.
2. Principles, Concepts and applications – Mechatronics: Nitaigour and Premchand Mahilik, Tata McGraw Hill – 2003.

VIII Semester
Department of Electrical Engineering

Course Code : EET472-5 **Course : FACTS**

L: 3Hrs, T: 0Hr, P: 0Hrs. Per week **Total Credits : 03**

Course Objectives

To understand the fundamentals of FACTS Controllers, Importance of controllable parameters and types of FACTS controllers and their application

Course Outcomes

At the end of this course students will demonstrate the ability to

1. Understand the effect of reactive power flow on performance of transmission line and types of FACTS controllers.
2. Understand the working of power converter used in FACTS devices
3. Understand the application of FACTS controller to shunt and series compensation.
4. Understand the application of FACTS controller for transient stability.

UNIT - I

FACTS Concept & general system consideration : Transmission inter connection, flow of power in an AC system, Factor affecting the loading capability, Power flow & dynamic stability consideration of transmission inter connection. Importance of controllable parameters, FACTS controller.

UNIT - II

Voltage sourced & current sourced converters : Basic concept of voltage sourced converters, single phase full wave bridge converter operation, single phase leg operation, square wave voltage harmonics for single phase bridge, three phase full wave bridge converter, sequence of valve conduction process in each phase leg, transformer connection for 12 pulse operation, three level voltage sourced converter, pulse width modulation converter, generalize technique of harmonic elimination & voltage control, basic concepts of current sourced converter, Thyristor based converters (with gate turn on), current source converter with turn off devices. Current source verses voltage source converter.

UNIT - III

Static Shunt Compensators: SVC and STATCOM : Objectives of shunt Compensation, Methods of Controllable VAR Generation, Static VAR Compensators SVC and STATCOM, Comparison between STATCOM and SVC, Static VAR System

UNIT - IV

Static Series Compensators: GCSC, TSSC, TCSC and SSSC : Objectives of series Compensation, Variable Impedance, Type Series Compensators, Switching Converter Type, Series Compensators, External (System) Control for Series Reactive Compensators.

UNIT - V

Static Voltage and Phase Angle Regulators: TCVR and TCPAR : Objectives of Voltage and Phase Angle Regulators, Approaches to Thyristor-Controlled Voltage and Phase Angle Regulators (TCVR and TCPARS) Switching Converter – Based Voltage and Phase Angle Regulators, Hybride Phase Angle Regulators.

UNIT - VI

Combine Compensators (UPFC, IPFC) and Special Purpose FACTS Controllers : The Unified Power Flow Controller (UPFC), Interline Power Flow Controllers Generalized and Multifunctional FACTS Controllers, Sub synchronous Resonance, NGH-SSR Damping Scheme, Thyristor- Controlled Braking Resistor(TCBR)

Text Books

1. Understanding FACTS, Naryan G. Hingorani and Laszlo Gyigyi (Standard Publishers).

Reference Books

1. Flexible AC Transmission System (FACTS)'Yong Hua Song and Johns (IEEE Publishers).
2. Thyristor Based FACTS controllers for Electrical Transmission System R. Mohan Mathur and Rajiv K. Verma (IEEE Press)

VIII Semester
Department of Electrical Engineering

Course Code : EET473-1 **Course : Power Quality**

L: 3Hrs, T: 0Hr, P: 0Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. To familiarize the student with power quality issues such as sag, flicker, harmonic distortion, unbalance, transients, etc.
2. To make the students acquainted with some power quality mitigating strategies,
3. To introduce the students about the measurements of power quality.

Course Outcomes

At the end of this course students will demonstrate the ability to

1. To understand the various power quality issues as sag, flicker, harmonic distortion, unbalance, transients, etc.
2. To suggest suitable mitigation strategies for some of the power quality issues
3. To select the tools required for the measurement of some of the power quality related issues.

Unit - I

Introduction to Electric Power Quality, Power Quality standards, Different Power Quality terms and definitions.

Unit - II

Voltage Sag and Interruptions, Sources of Voltage sag and interruptions, type and characteristics of voltage sag and interruptions, Factors affecting characteristics of voltage sag and interruptions, behavior of different equipments during voltage sag, concept of area of vulnerability, CBEMA and ITI Curves .

Unit - III

Voltage Swell and transient over voltage, sources of over voltage like capacitor switching, load switching, lighting etc, various causes of voltage flicker and their effects. Short term and long term flickers, various means to reduce flickers, Transient over voltages, sources, impulsive transients, switching transients, Effect of surge impedance and line termination, control of transient voltages.

Unit -IV

Harmonic distortions, voltage and current harmonics, THD, sources of harmonics, ill effects of harmonics, interharmonics, harmonics filters, IEEE 519-1992 definitions, reactive power under harmonics, K-rated transformer.

Unit - V

Voltage Unbalance, Impact on equipment performance, other power quality related issues like EMI, noise, notching, DC offset , Typical wiring and grounding problems causing poor power quality, solution to wiring and grounding problems.

Unit - VI

Need of power quality monitoring and approaches followed in power quality monitoring. Power quality monitoring objectives and requirements. Initial site survey. Power quality Instrumentation. Selection of power quality monitors, selection of monitoring location and period. System wide and discrete power quality monitoring. Setting thresholds on monitors, data collection and analysis. Selection of transducers. Harmonic monitoring, Transient monitoring, event recording and flicker monitoring, Mitigation techniques at different environments.

Text Books

1. Electrical power system quality – R. C. Dugan, Mark F. McGranghan, Surya santoso, H. Wayne Beaty, Second edition, McGraw Hill.
2. Understanding power quality problems, voltage sag and interruptions - M. H.J. Bollen, IEEE press, 2000, series on power engineering
3. Power Quality: C.Sankaran, CRC Press

Reference Books

1. IEEE std 519-1992/ IEEE std 1159 IEEE recommended practices and requirements for harmonics control in electrical power system.
2. Power system quality assessment: J. Arrillaga, M.R. Watson, S. Chan, John Wiley and sons.

VIII Semester
Department of Electrical Engineering

Course Code : EET473-2 **Course : Industrial Electrical Systems**

L: 3Hrs, T: 0Hr, P: 0Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of this course is to create awareness regarding component specifications, design capabilities, statutory provisions and testing &commissioning of industrial electrical systems, upto 33 kV.

Course Outcomes

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

1. Assess the electrical load and select the conductors suitable to carry load currents
2. Calculate the short circuit current at different locations and select proper switchgear
3. Design and select suitable components of starters for induction motor, understand its operation and select capacitors for reactive power management.
4. Select and understand procedures for installation, testing and commissioning practices for transformers, substations, DG & UPS Systems.
5. Design PCC & MCCs for residential, commercial and industrial installations.
6. Understand important features of IS 3043 for earthing, protection of building against Lightening & IE Rules

Unit - I

Assessment of Electrical Load & Selection of Cables & Conductors : Electrical load assessment: Categories & types of electrical load, preparing load list, connected load, demand/ diversity/ load/ power factor, TOD tariff, industrial electric bills.

Cables, conductors &busbar : Construction, selection, installation, testing of LT/HT cables, overload and short circuit ratings, rating factors, overhead line conductors, aluminum & copper busbar.

Unit - II

Symmetrical Short Circuit Calculations, Switching & Protective Devices : Symmetrical short circuit calculations: Determining symmetrical short circuit currents for selecting appropriate switchgear ratings, determining specifications of current limiting series reactor.

Switching & Protective devices : Types, specifications and selection of isolators, switches, switch-fuse units, ELCB, MCB, MCCB, ACB,VCB and SF6 circuit breakers; dropout/horn gap fuses, AB switches, power contactors, capacitor duty contactors.

Unit - III

Electric Supply to Induction Motors and Reactive Power Management in Industries : Electric supply to induction motors: Power & control circuit for manual/automatic DOL, star-delta and autotransformer starters, working of these starters, selection of contactors, overload relays, short circuit protective devices for induction motors.

Reactive power management in industries : Determining kVAr rating of PF improvement by using power triangle, calculation of payback period of capital cost of capacitor installation against reduction in system losses.

Unit - IV

Transformers, Substations, DG, UPS and Batteries : Transformers: Specifications, ratings, selection, installation, testing & commissioning.

Substations : 11 & 33 kV, indoor/outdoor substations; plan/elevation/clearances

UPS and Batteries : UPS systems, battery banks, sizing and selection of UPS and battery banks.

Unit - V

Design of Residential, Commercial and Industrial Installations : Design of PCC, MCC, APFC Panels; selection of all associated electrical apparatus, busbars, cables, switchgear, protective devices, instruments, testing, commissioning. Introduction to lightening protection of buildings.

Unit - VI

Earthing, & IE Rules : Earthing& IE Rules/ CEA Regulations:

Earthing (IS 3043) : Necessity of earthing, concept of system and equipment earthing, definition of various terms, types of earthing, earth tester, and measurement of earth resistance.

IE Rules : Important IE rules applicable to residential, commercial and industrial installations. Central Electricity Authority (Measures relating to Safety and Electric supply) regulations 2010.

Text Books

1. Electric Power Distribution: A.S. Pabla
2. Design of Electrical Installation: V.K. Jain & A. Bajaj
3. Residential Commercial and Industrial Systems: H. Joshi, McGraw Hill Education
4. Handbook of Electrical Power Distribution: G. Ramamurthy

Reference Books

1. Indian Electricity Rules latest edition
2. IS 3043 Code of practice for earthing
3. Manufacturers' catalogues

VIII Semester
Department of Electrical Engineering

Course Code : EET473-3 **Course : Fuzzy Logic and Neural Network**

L: 3Hrs, T: 0Hr, P: 0Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. To introduce students to basic concepts of fuzzy logic.
2. To educate students in applying the fuzzy logic concept to engineering applications.
3. To introduce student basic concepts of neural networks.
4. To educate students in applying the neural network concept to engineering applications.

Course Outcomes

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

1. Understand the basic concepts of fuzzy logic.
2. Apply the fuzzy logic concept to engineering applications.
3. Understand the basic concepts of neural networks.
4. Apply the neural network concept to engineering applications.

Unit - I

Introduction of Fuzzy Logic : Introduction of artificial intelligence, fuzzy logic concept, fuzzy v/s crisp set, properties of fuzzy sets, linguistic variables, operation of fuzzy sets.

Unit - II

Fuzzy Logic Model : Introduction, membership functions, fuzzy if-then rules, fuzzy inference, defuzzyfication.

Unit - III

Fuzzy Logic Applications : Fuzzy knowledge based systems, fuzzy logic in engineering applications

Unit - IV

Introduction of Neural Networks : Introduction of biological and artificial neurons, artificial neural models and network architecture, learning strategies (supervised, unsupervised, reinforced), learning rules.

Unit - V

Types of Neural Networks : Single layer feed-forward neural network, Multi layer feed forward neural network, associative memory.

Unit - VI

Neural Network Applications : Neural network in engineering applications.

Text Books

1. Neural Networks, Fuzzy Logic and Genetic Algorithms: S. Rajsekaran and G. A. Vijayalaxmi.
2. An Introduction to Fuzzy Control: D. Draiankov.
3. Fuzzy Sets and Fuzzy Logic -Theory and Application: George D. Klir and Bo Yan
4. Neural Network Design: Hagan, Demuth, Beale, PWS Publishing Company.

Reference Books

1. Neural Network and Fuzzy System: Bart Kosko.
2. Neural Network design by Hagan: Demuth and Beale.
3. First Course on Fuzzy Theory and Applications: K. H. Lee

VIII Semester
Department of Electrical Engineering

Course Code : EET474 | **Course : Project Phase - II**

L: 0Hrs, T: 0Hr, P: 16Hrs. Per week | **Total Credits : 08**

Course Objectives

The objective of the course is to prepare the students:

6. To make students analyze engineering problems by applying knowledge of engineering fundamentals.
7. To familiarize students in designing a system or process, conduct related experiments and interpret the data.
8. To educate students in applying modern engineering and software tools and prepare them to adapt to new technological changes in solving engineering problems.
9. To incorporate professional skills required for timely completion of a given task, to work in result oriented direction individually and in a group for a sustainable solution.
10. To prepare students in communicating effectively on subject matter and writing effective project report.

Course Outcomes

Upon completion of this course students must be able to;

7. Analyze engineering problems by applying knowledge of engineering fundamentals.
8. Design a system or process, conduct related experiments and interpret required data
9. Apply modern engineering and software tools.
10. Acquire professional skills required for timely completion of given task.
11. Communicate effectively on subject matter and write effective project report with presentation.
12. Acquire skills to work in a result oriented direction individually and in group for sustainable solution and be ready to adopt new technological changes to solve engineering problems.

VIII Semester
Department of Electrical Engineering

Course Code : EET475-1 **Course : Power System Protection**

L: 3Hrs, T: 0Hr, P: 0Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of this course is to introduce fundamental principles of operation of the Protective Relays, Relaying Systems and their application for protection of overhead lines, transformers, generators, motors and busbars.

Course Outcomes

After completion of this course, students should be able to

1. Understand basic features of protection system and its components. (L1, L2)
2. Apply the principle of numerical techniques for protective relays (L3, L4).
3. Apply principles of overcurrent relaying and achieve relay coordination for low and medium voltage distribution feeders (L4, L5)
4. Apply distance relaying techniques to High Voltage Transmission lines (L4, L5)
5. Design protection schemes for equipment such as transformers, generators, motors etc. (L5, L6)

Unit - I : Introduction to fundamentals of protection System (8H)

Faults, Primary & backup protection, Instrument transformers. Review of electromechanical relays

Unit - II : Fundamentals of Numerical Protection (8 H)

Block diagram of Numerical Relay, Data acquisition System (DAS), Numerical Relaying Algorithms and techniques for computation of V, I, R, L, Z; Digital Fourier Transform techniques/ algorithm for extracting the fundamental frequency component, evaluation of Fourier coefficients, Numerical based on above techniques.

Unit - III : Overcurrent Protection (8H)

Introduction to overcurrent protection and overcurrent relay coordination, development of Numerical overcurrent relays.

Unit - IV : Distance Protection (8H)

Distance protection; development of Numerical distance relays.

Unit - V : Equipment Protection Schemes (8H)

Transformer, generator, induction motor and busbar protection; development of Numerical relays for equipment protection.

Recommended Self-Study: Synchro-phasors and its application for power system protection.

Text Books

1. Fundamentals of Protective Relaying: Y G Paithankar, S R Bhide
2. Computer Relaying for Power Systems: A G Phadke, James S Thorp- John Wiley and Sons
3. Power System Protection and Switchgear- Badri Ram, Vishwakarma, Mc Graw Hill
4. Digital Power System Protection: S R Bhide , PHI

Reference Books

1. Art & Science of Protective Relaying: Russel Mason
2. Power System Relaying: Stanley H Horowitz, A G Phadke; Willey
3. Other reference material (e.g. e-resources): Relay Manufacturer's catalogues and application notes, NPTEL online lectures

Other reference material (e.g. e-resources)

Relay Manufacturer's catalogues and application notes, NPTEL online lectures.

VIII Semester
Department of Electrical Engineering

Course Code : EET475-2 **Course : Digital Signal Processing**

L: 3Hrs, T: 0Hr, P: 0Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. To make aware with the different types of signals and systems with their representations..
2. To make understand the different transform for the discrete time signals.
3. To introduce with representation and designing of the digital filter.

Course Outcomes

At the end of this course students will demonstrate the ability to

1. Represent signals mathematically in continuous and discrete-time, and in the frequency domain.
2. Analyse discrete-time systems using z-transform.
3. Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms.
4. Represent and design digital filters for various applications.
5. Apply digital signal processing for the analysis of real-life signals.

Unit - I

Discrete-time signals and systems : Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.

Unit - II

Z-transform : z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using z transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z-transforms.

Unit - III

Discrete Fourier Transform : Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Implementation of Discrete Time Systems.

Unit - IV

Representation of Digital Filters : Basic structures of IIR and FIR filter, Direct form, cascade and parallel structure

Unit - V

Design of Digital Filters : Design of IIR filter by Impulse Invariant method, Bilinear Z Transformation with prewarping effect, Matched Z Transformation Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Bandstop and High-pass filters. Design of FIR filters by Fourier Series Method, Windowing Method. Introduction to multi-rate signal processing.

Unit - VI

Applications of Digital Signal Processing : Applications of Digital Signal Processing to Electrical system

Text Books

1. Discrete Time Signal Processing: A.V. Oppenheim and R. W. Schafer, Prentice Hall, 1989.
2. Digital signal processing Theory & Applications: N.G.Palan, Tech Max Publication Reference Books, Prows and Manolakis, PHI Ltd, 3rd Edition
3. Digital Signal Processing: Principles, Algorithms and Applications: J. G. Proakis and D.G. Manolakis, Prentice Hall, 1997.
4. Digital Signal Processing- A computer based approach: S. K. Mitra, McGraw Hill, 2011.

Reference Books

1. Digital Signal Processing: S Salivahanan, AVallavaraj, Mc. Graw Hill Publication. 2nd Edition 2. Discrete time signal processing, ,
2. Theory and Application of Digital Signal Processing: L. R. Rabiner and B. Gold, Prentice Hall, 1992.
3. Introduction to Digital Signal Processing: J. R. Johnson, Prentice Hall, 1992.
4. Digital Signal Processing: D. J. DeFatta, J. G. Lucas andW. S. Hodgkiss, John Wiley & Sons, 1988.
5. DSP First Hardcover : James MacClellan, Ronald Schafer, Mark Yoder

VIII Semester
Department of Electrical Engineering

Course Code : EEP475-1 **Course : Power System Protection Lab**

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

Course Objectives

To study different power system protective relay equipments along with their respective characteristics by conducting suitable experiments.

Course Outcomes

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

1. Analyze, apply and co-relate principle of protective relaying with laboratory experimental work.
2. Carry out the connection of the circuit by choosing proper terminals and perform the experiment using proper relay settings.
3. Analyze the observed data & make valid conclusion by plotting characteristics of relay.
4. Write Journal with effective presentation of diagrams and characteristics.

Proposed Syllabus

Students need to perform 08 to 09 practical based on the theory course of Power System Protection.

VIII Semester
Department of Electrical Engineering

Course Code : EEP475-2 **Course : Digital Signal Processing Lab**

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

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 demonstrate the ability to

CO1: Represent and perform different operations on signals

CO2: Analyse discrete-time systems using different transform.

CO3: Represent and design digital filters for various applications.

List of Experiment

1. Write a program to plot basic discrete time signals.
2. Write a program to convert continuous time signal into discrete time signal and check the effect of sampling frequency.
3. Write a program to perform basic operations on discrete time signals.
4. Write a program to perform convolution of two finite discrete time signals.
5. Write a program to find correlation of two finite discrete time signals.
6. Write a program to obtain Z-transform of DT system & plot its pole-zero plot in Z domain. Comment on stability.
7. Write a program to perform circular convolution of the DT sequences x1(n) and x2(n) using DFT.
8. Write a program to find the FFT and study the effect of change in value of N.
9. Write a program for designing and implementing the FIR filter of specified specification.
10. Write a program for designing and implementing the FIR filter of specified specification.

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

Note : The experiments will be conducted through SCILab / Python.

VIII Semester
Department of Electrical Engineering

Course Code : EETH81-1 **Course : Advanced Linear Continuous System : Applications with MATLAB Programming and Simulink**

L: 4Hrs, T: 0Hr, P: 0Hrs. Per week

Total Credits : 04

Course Objectives

The objective of the course is to prepare the students:

1. To understand the various methodology of modelling in state space, state transition matrix and solution in state equation.
2. To understand the concepts of controllability, obervability, controller design, and observer design.

Course Outcomes

Upon the completion of this course, student will be able to:

1. Analyze continuous time system using state space technique.
2. Analyze stability of the system using different methods.
3. Analyzesolution of space space model.
4. Design state feedback and observer for continuous linear system.

Unit - I

Introduction to State Space, State Space Representation : Companion Form (Controllable / Observable Canonical Form), Extended Controllable Canonical Form, Diagonal Canonical Form (Different forms), Numerical Examples on State Space Modelling (Part II), Modelling of Mechanical Systems in State Space, Modelling of DC Servo Motor, Determination of Transfer Function from State Space Model

Unit - II

Stability Analysis in State Space : Concept of Eigenvalues and Eigenvectors, Stability Analysis in State Space, Stability Analysis in State Space: Lyapunov Stability Analysis (Sylvester's Criterion),Stability Analysis in State Space: Lyapunov Stability Analysis (Direct Method)

Unit - III

Concept of Diagonalization, Solution of State Equation, Solution of State equation (Forced system)Steady State Error for State Space System, State Transition Matrix using different methods.

Unit - IV

Controllability / Obervabilityin State Space, MATLAB Programming with State Space and Pole Placement by State Feedback design.

Unit - V

Tracking Problem in State Feedback Design, State Observer Design

Text Books

1. Modern Control Engineering: Katsuhiko Ogata, , PHI, 2009.
2. Modern Control Design: AshishTewari, with MATLAB and SIMULINK, Wiley, 2002.
3. Modern Control Engineering: D. Roy Choudhuary, PHI, 2005.

Reference Books

1. Design of Feedback Control Systems: Stefani et al, Oxford, Fourth edition, 2002.

Research papers

(1) D.G. Luenberger , " An Introduction to Observer," IEEE Trans. Automatic Control, pp. 596- 602, 1971.

(2) S-H Hou, "A Simple proof of the Leverrier Faddeev characteristic polynomial algorithm," Society for Industrial and Applied Mathematics, vol. 40, no. 3, pp. 706-709, Sept. 1998.

VIII Semester
Department of Electrical Engineering

Course Code : EETH81-2 **Course : Mapping Signal Processing Algorithms to DSP Architectures**

L: 4Hrs, T: 0Hr, P: 0Hrs. Per week

Total Credits : 04

Course Objectives

The objective of the course is to prepare the students:

1. To introduce various techniques of digital signal processing that are fundamental to various industrial applications.
2. To learn the basis of DSP systems, its theory and practical implementation of different kind of algorithms

Course Outcomes

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

1. Comprehend the knowledge and concepts of digital signal processing techniques.
2. Understand the digital system models, architectures with its implementation
3. Discuss about communication systems in DSP
4. Understand the specialized architectures of DSP

Unit - I

Digital System : Review of digital logic, timing and power in digital circuits, implementation costs and metrics, architecture cost components, multi-objective optimization, number representation, scientific notation and floating point

Unit - II

DSP System Models : Basic FIR Filter, serial FIR filter architectures, simple programmable architecture, block diagrams and SFGs, data flow graph, FIR and IIR filter iteration period, constraint analysis for IPB computation, General IPB computation, parallel architecture, pipelining FIR filter with examples, balanced pipeline, retiming basic concept.

Unit - III

Implementation of DSP Models : Hardware assumptions and constraint analysis, mathematical formulation, biquad filter, hardware architecture, complete biquad hardware, FFT sysnthesis, ASAP schedule, utilization efficiency, ALAP schedule, iteration period bound and scheduling, retiming for scheduling, blocked schedules, overlapped schedules, allocation, binding and scheduling, Heuristic approaches to scheduling, mathematical formulation, ILP formulation, List scheduling, Force directed scheduling.

Unit - IV

Architectures : Software compilation, optimization examples, loop optimization, software pipelining, FFT optimization, background of CPU and FPGA, on chip communication basics, many-to-many communication, AXI bus handshaking.

Unit - V

Memory and Communication System : DMA and arbitration, network on chip basics, No C: topologies and metrics, routing, switching and flow control, systolic arrays backgrounds with examples, CORDIC algorithm.

Unit - VI

Specialised Architectures : Parallel implementation of FIR filters, unfolding transformation, look ahead transformation, introduction to GPUs and matrix multiplication

Text Books

1. Architectures for Digital Signal Processing: Peter Pirsch John Weily, 2007
2. Digital Signal Processing: Avatar Singh and S. Srinivasan, Thomson Learning, 2004.
3. Digital signal processing principles – algorithms and applications: John G. Proakis, -PHI- 2002, 3rd edition

Reference Books

1. VLSI digital Signal Processing Systems design and Implementation: KeshabK.Parhi, Wiley India, 2007.
2. Digital Signal Processor-Architectures, implementation, and Applications: Sen M. Kuo, Woon-Seng S. Gan, pearson prentice hall, 2005.
3. Digital Signal Processing - A practical approach: Ifeachor E. C., Jervis B. W PearsonEducation, PHI/ 2002
4. Digital Signal Processors: B Venkataramani and M Bhaskar TMH, 2002

VIII Semester
Department of Electrical Engineering

Course Code : EETH81-3 **Course : Power System Analysis**

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

Course Objectives

The objective of the course is to prepare the students:

1. To understand the concepts of per-unit system and modelling of transmission line.
2. To learn the modelling of single phase and three phase transformer to find effective inductance under different conditions.
3. To learn the functioning of a synchronous machine and represent it with simple models.
4. To study the load modelling under steady state and transient state condition and compare the same as application point of view

Course Outcomes

At the end of this course students will demonstrate the ability to

1. 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
2. Find effective inductance under open and short circuit condition of single phase transformer, draw per phase equivalent circuit of three-phase transformer.
3. Analyze the three phase armature currents, field current and different reactances in d-q frame at different operating conditions in synchronous generator.
4. Compare the static and dynamic loads and understand the concept of mathematical modelling of induction motor in brief.

Unit - I

Overview of power System : Single line diagram and per unit system, transmission line parameters, power flow problem using GS, NR & FDC methods and their comparison

Unit - II

Transmission line Modelling : Introduction, derivation of terminal V, I relations, waves on transmission lines, transmission matrix, lumped circuit equivalent, simplified models, complex power transmission and their analysis power circle diagram.

Unit - III

Transformer Modelling : Introduction, single phase transformer model, three phase transformer connection, per phase analysis, regulating transformer for voltage & phase angle control.

Unit - IV

Synchronous Generator Modelling I : Basic models, electrical equations & mechanical equations, Stator circuit equations, Stator self, stator mutual and stator to rotor mutual inductances.

Unit - V

Synchronous Generator Modelling II : 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 generator

Unit - VI

Load Modelling : 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:

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: A. Chakrabarti, S. Halder, PHI, Eastern Economy Edition 3rd edition
3. Related IEEE papers/ NPTEL lectures

VIII Semester
Department of Electrical Engineering

Course Code : EETH81-4 | **Course : Power System Dynamics, Control and Monitoring**

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

Course Objectives

The objective of the course is to prepare the students:

1. To give a broad knowledge of dynamic system and links between power system steady state and transient analysis.
2. To study voltage and frequency stability analysis of transient systems.
3. To understand frequency control, Voltage control, power system transient and Dynamic stability control

Course Outcomes

Upon the completion of this course, student will be able to:

1. CO1: Analyze the different stability of the power system.
2. CO2: Explain how dynamic systems are controlled.
3. CO2: Use mathematical tools and models to formulate and solve stability problems
4. CO3: Apply control and stability technique to power system.

Unit - I

Concept of Power system stability, Types of stability, Classical model of single machine connected to infinite bus and a multi machine system, mathematical modeling of power system elements for stability studies.

Unit - II

Small Signal Analysis, Fundamental concepts of Stability of Dynamic Systems, Small Signal Stability of Single Machine Infinite Bus(SMIB) System, Effects on Excitationsystem,Block diagram representation with exciter and AVR, Power System Stabiliser (PSS), State matrix including PSS, Small Signal Stability of Multi Machine Systems.

Unit - III

Rotor angle stability, classical method of rotor angle stability, equal area criteria for SMIB system, two machine systems, Numerical solution of swing equation, Multi-machine stability, factor affecting transient stability.

Unit - IV

Voltage stability & Voltage Collapse, Reactive power and voltage control, Voltage stability analysis, different criteria for voltage stability. Unit V

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

Text Books

1. Power System Control and Stability: Anderson and Fourd , Galgotia Publications, 1981
2. Power System Dynamics: K R Padiyar, B.S. Publishers, 2003, 2nd Edition.
3. Power system Stability and Control: P Kundur, , McGraw-Hill Inc., 1994
4. Power System Dynamics and Stability: P W Sauer & M A Pai, Pearson, 2003
5. Power System Stability: E W Kimbark, Wiley & IEEE Press, 1995
6. Electric Power Systems Dynamics: Yao-nan-Yu, , Academic Press, 1983

VIII Semester
Department of Electrical Engineering

Course Code : EETM81 **Course : Power System Protection**

L: 3Hrs, T: 0Hr, P: 0Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of this course is to introduce basic operation of protective relays and protection schemes for distribution lines and electrical equipment.

Course Outcomes

After completion of this course, the student shall:

1. Understand need for protection and basic features of protection schemes.
2. Understand relay operating principles and their applications.
3. Analyse the features of current based protection and design relaying schemes with coordination.
4. Apply relaying schemes for protection of electrical equipment.

Unit - I : Introduction to Power System Protection : Need for protective schemes, Nature and Cause of Faults, Types of Fault,Effects of Faults, Fault Statistics, Zones of Protection, Primary and Backup Protection, Essential Qualities of Protection, Current Transformers for protection.

Unit - II : Relay Construction and Operating Principles : Introduction, Electromechanical Relays, Static Relays – Merits and Demerits of Static Relays, Numerical Relays, Comparison between Electromechanical Relays and Numerical Relays.

Unit - III : Fuses : Introductions, Definitions, Fuse Characteristics, Types of Fuses, Applications of HRC Fuses, Selection of Fuses.

Unit - IV : Overcurrent Protection : Introduction, Time – current Characteristics, Current Setting, Time Setting, Overcurrent Protective Schemes, Reverse Power or Directional Relay, Protection of Parallel Feeders and Ring Mains, Earth Fault and Phase Fault Protection.

Unit - V : Equipment Protection : Introduction, Differential Relays, Simple Differential Protection, Percentage or Biased Differential Relay.Rotating Machines Protection: Protection of Generators, Transformers and Motors.

Text Books

1. Fundamentals of power System Protection: Y.G. Paithankar, S.R. Bhide

Reference Books

1. Power System Protection and Switchgear: Badri Ram, D. N. Vishwakarma
2. e-resources of NPTEL