DEPARTMENT OF ELECTRICAL ENGINEERING

Course Book for

B.Tech. in Electrical & Electronics Engineering

Visvesvaraya National Institute of Technology

2015

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Vision and Mission of the Department

VISION:

The Department of Electrical Engineering will provide programs of the highest quality to produce world class engineers who can address challenges of the millennium. It commits itself to impart the skills, knowledge and attitudes to create, interpret, apply and disseminate engineering to build better future for humankind. This department will endeavor to strengthen the facilities to provide solutions to relevant Electrical Engineering problems.

MISSION:

The mission of the Electrical Engineering Department is :-

1. To create the environment that facilitates learning the fundamentals of Electrical Engineering.
2. To impart the knowledge in Electrical Circuits, Power Systems, Electrical Machines, Power Electronics, Electrical Drives and Non-conventional Energy Systems.
3. To provide premier education through dedicated teaching, innovation and research.
4. To cater to practical issues by adapting to technical, economical and social trends.
5. To prepare students to face challenges in the global environment.

Program Educational Objectives

The main **Programme Educational Objectives** of UG program are :-

1. To **develop graduate engineers** ready for contemporary electrical power and energy industry.
2. To develop graduate engineers having **enhanced analytical skills** to solve industrial problems.
3. To build the students' **capacity in pursuing knowledge** in the emerging areas of Electrical and Electronics Engineering.
4. To produce graduates with perspective for environmental issues by sensitizing and building the **awareness of green technologies**.
5. To produce graduates with **problem solving culture** through familiarization with the state-of-art facilities in Electrical and Electronics Engineering laboratories.

Brief about B.Tech. program:

The main Objectives: of B.Tech. program are

1. To develop specialised manpower for electrical power and energy industry.
2. To enhance analytical skills so as to enable to solve complex industrial problems.
3. To augment the student's capacity by offering projects in emerging areas of Electrical & Electronics Engineering.
4. To improve student's perspective towards environmental issues by sensitizing and building the awareness of green technologies.
5. To inculcate the culture of research oriented projects with state of art facility laboratories in Electrical & Electronics Engineering.

About Grades, Credits, SGPA & CGPA

Department of Electrical Engineering offers B.Tech. program namely B.Tech. in Electrical & Electronics Engineering. This is eight semester program, where in students have to complete certain number of credits as indicated in Table 1. Each subject (or course) has certain number of credits. There are two type of subjects: Core and Elective. Core courses are compulsory and some courses from electives are to be taken to complete the required credits.

Program Core (PC)		**Program Elective (PE)**	
Category	Credit	Category	Credit
Basic Science (BS)	18	Departmental Electives (DE)	45
Engineering Science (ES)	20	Humanities & Management (HM)	
Humanities (HU)	05	Open Courses (OC)	
Departmental Core (DC)	82		
Total	125	Total	45
Grand Total PC + PE			170

Table 1

The number of credits attached to a subject depends on number of classes in a week. For example, a subject with 3-0-2 (L-T-P) means it has 3 Lecture, 0 Tutorial and 2 Practical hours in a week. This subject will have four credits (3x1 + 0x1 + 2x0.5 = 4). If a student is declared pass in a subject, then he/she gets the credits associated with that subject. Depending on marks scored in a subject, student is given a Grade. Each grade has got certain grade points as follows:

Grades	AA	AB	BB	BC	CC	CD	DD	FF
Grade Points	10	09	08	07	06	05	04	Fail

The performance of a student will be evaluated in terms of two indices, viz. the Semester Grade Point Average (SGPA) which is the Grade Point Average for a semester and Cumulative Grade Point Average (CGPA) which is the Grade Point Average for all the completed semesters at any point of time. SGPA & CGPA are:

$$\mathbf{SGPA} = \frac{\sum_{\text{semester}}(\text{CoursecreditsXGradepoints})\,\text{forallcoursesexceptaudit}}{\sum_{\text{semester}}(\text{Coursecredits})\,\text{forallcoursesexceptaudit}}$$

$$\mathbf{CGPA} = \frac{\sum_{\text{Allsemester}}(\text{CoursecreditsXGradepoints})\,\text{forallcourseswithpassgradeexceptaudit}}{\sum_{\text{Allsemester}}(\text{Coursecredits})\,\text{forallcoursesexceptaudit}}$$

Students can take few audit subjects. i.e., they can attend the classes and do home work and give exam also, but they will not get any credit for that subject. Audit subjects are for self development of students.

The Cumulative Grade Point Average (CGPA) earned by the student on a scale of 10 is an indication of his/her academic standing in the class. Where, for the purpose of student's placements and/or their eligibility for competitive exams etc., a conversion of CGPA to percentage is required, a CGPA of 10 may be deemed to be 100% and accordingly the following table is used for conversion. Further, the institute does not issue certificate towards position/rank at the class or institute level.

CGPA	4.00	5.0	6.0	7.0	8.0	9.0	10.0
Percentage	40	50	60	70	80	90	100

Details about faculty members of Electrical Engineering Department

	Name of Faculty Member	Designation	Qualification	Areas of Specialization
1	Aware M.V.	Professor	Ph.D.	Electrical Drives, Power Electronics, High Voltage Engineering
2	Ballal M.S.	Associate Professor	Ph.D.	Condition Monitoring, Incipient Fault Detection, Power Quality
3	Bhat S.S.	Associate Professor	Ph.D.	Power System Analysis
4	Bhide S.R.	Professor and HoD	Ph.D.	Power System Protection, Artificial Intelligence Technique
5	Borghate V.B.	Associate Professor	Ph.D.	Power Electronics, Electrical Machine Design
6	Chaudhari M.A.	Associate Professor	Ph.D.	Power Quality, Power Electronics
7	Dhabale A.	Assistant Professor	M.Tech.	Control Systems, Electrical Drives
8	Junghare A.S.	Associate Professor	Ph.D.	Power Systems, Control Systems
9	Kale V.S.	Associate Professor	Ph.D.	Power System Protection, A.I Applications in Power Systems
10	Keshari R. K.	Assistant Professor	Ph.D.	Power Electronics, Electric drives, Electric vehicle
11	Khedkar M.K.	Professor	Ph.D.	Power System, Distribution automation, RES
12	Kulkarni P.S.	Associate Professor	Ph.D.	Power Systems Operation & Control, Renewable Energy Systems
13	Lokhande M. L.	Assistant Professor	Ph.D.	Power Electronics, Electric machine, Photovoltaics
14	Patne N.R.	Assistant Professor	Ph.D.	Power Systems, Power Quality
15	Ramteke M.R.	Associate Professor	Ph.D.	Power Electronics
16	Satputaley R.J.	Assistant Professor	M.Tech.	Power Systems, Power Quality
17	Suryawanshi H.M.	Professor	Ph.D.	Power Electronics, Electrical Drives
18	Tambay S.R.	Assistant Professor	M.Tech.	Power System Protection, Power System Analysis
19	Umre B.S.	Associate Professor	Ph.D.	Power Systems, Electrical Machines

Courses to register in First Year B.Tech.

1st year B Tech scheme for 2015-16 batch

Physics Stream (Section R, S, T,U, L)

I Semester			
Code	**Course**	**L-T-P**	**Credits**
AML151	Engineering Mechanics	3-1-0	4
AMP151	Engineering Mechanics Laboratory	0-0-2	1
HUL101	Communication Skills	2-0-2	3
MAL101	Mathematics – I	3-1-0	4
MEL101	Engineering Drawing	3-0-0	3
MEP101	Engineering Drawing Practical	0-0-2	1
PHL101	Physics	3-1-0	4
PHP101	Physics Laboratory	0-0-2	1
SAP101	Health Information and Sports –Part 1	0-0-2	0
		Total Credits	21
II Semester			
Code	**Course**	**L-T-P**	**Credits**
CHL101	Chemistry	3-1-0	4
CHP101	Chemistry Laboratory	0-0-2	1
CSL101	Computer Programming	3-0-2	4
EEL101	Electrical Engineering	3-1-0	4
EEP101	Electrical Engineering Laboratory	0-0-2	1
HUL102	Social Science	2-0-0	2
MAL102	Mathematics – II	3-1-0	4
MEP102	Workshop	0-0-4	2
SAP102	Health Information and Sports –Part 2	0-0-2	0
		Total Credits	22

Chemistry Stream (Section W, X,Y,Z, N)

I Semester			
Code	**Course**	**L-T-P**	**Credits**
CHL101	Chemistry	3-1-0	4
CHP101	Chemistry Laboratory	0-0-2	1
CSL101	Computer Programming	3-0-2	4
EEL101	Electrical Engineering	3-1-0	4
EEP101	Electrical Engineering Laboratory	0-0-2	1
HUL102	Social Science	2-0-0	2
MAL102	Mathematics – I	3-1-0	4
MEP102	Workshop	0-0-4	2
SAP102	Health Information and Sports –Part 2	0-0-2	0
		Total Credits	22
II Semester			
Code	**Course**	**L-T-P**	**Credits**
AML151	Engineering Mechanics	3-1-0	4
AMP151	Engineering Mechanics Laboratory	0-0-2	1
HUL101	Communication Skills	2-0-2	3
MAL101	Mathematics – II	3-1-0	4
MEL101	Engineering Drawing	3-0-0	3
MEP101	Engineering Drawing Practical	0-0-2	1
PHL101	Physics	3-1-0	4
PHP101	Physics Laboratory	0-0-2	1
SAP101	Health Information and Sports –Part 1	0-0-2	0
		Total Credits	21

CREDIT REQUIREMENTS FOR B.TECH (BRANCH ELECTRICAL AND ELECTRONICS ENGINEERING)

Program Core (PC)		**Program Elective (PE)**	
Category	Credit	Category	Credit
Basic Science (BS)	18	Departmental Electives (DE)	45
Engineering Science (ES)	20	Humanities & Management (HM)	
Humanities (HU)	05	Open Courses (OC)	
Departmental Core (DC)	82		
Total	125	Total	45
Grand Total PC + PE			170

SEMESTER-WISE CREDITS

SR NO	SEMESTER	CREDITS
1	FIRST	21
2	SECOND	22
3	THIRD	23
4	FOURTH	23
5	FIFTH	23
6	SIXTH	20
7	SEVENTH	21
8	EIGHTH	17
	TOTAL CREDITS	170

Details of credits:

III Semester				IV Semester			
CORE				**CORE**			
Code	**Course**	**L-T-P**	**Cr**	**Code**	**Course**	**L-T-P**	**Cr**
EEL201	Network Theory	3-1-0	4	EEL203	Electrical Machines-I	3-0-0	3
EEL202	Signals and Systems	3-1-0	4	ECL207	Digital Circuits	3-0-0	3
EEL204	Instrumentation	3-0-0	3	EEL225	Electrical Power Systems-I	3-0-0	3
ECL206	Electronic Devices and Circuits(EDC)	3-0-0	3	EEL226	Power Electronics	3-1-0	4
MAL201	Integral Transforms and PDE	3-0-0	3	EEP203	Electrical Machines-I Lab	0-0-2	1
EEP201	Network Lab	0-0-2	1	EEP226	Power Electronics Lab	0-0-2	1
EEP204	Instrumentation Lab	0-0-2	1	ECP207	Digital Circuits Lab	0-0-2	1
ECP206	Electronic Devices and Circuits LAB	0-0-2	1				
III Semester				**IV Semester**			
ELECTIVE (Any one)				**ELECTIVE (Any two)**			
EEL206	Elements of Electromagnetic	3-0-0	3	EEL215	Electrical Power Utilization	3-0-0	3
PHL202	Introduction to Material Science	3-0-0	3	EEL227	Power Station Practice	3-0-0	3
				MAL205	Numerical Methods & Probability Theory	3-0-0	3
				ELECTIVE LAB (Any one)			
				EEP223	Programming Techniques and Simulation Lab	0-0-2	1
				EEP230	Electrical Workshop lab	0-0-2	1
	Total No of Credits	**23**			**Total No of Credits**	**23**	

V Semester				VI Semester			
CORE				**CORE**			
Code	**Course**	**L-T-P**	**Cr**	**Code**	**Course**	**L-T-P**	**Cr**
EEL302	Electrical Machine-II[#]	3-0-0	3	EEL304	Electric Drives & Their Control	3-1-0	4
EEL325	Electrical Power System-II[#]	3-1-0	4	EEL329	Switchgear and Protection	3-0-0	3
EEL326	Industrial Automation[#]	3-0-0	3	EEL330	Microcontrollers	3-0-0	3
EEL305	Control System-I	3-1-0	4	ECL320	Linear Electronic Circuits	3-0-0	3
EEL307	Electrical Machine Design	3-0-0	3	EEP329	Switchgear and Protection Lab	0-0-2	1
EEP326	Industrial Automation	0-0-2	1	EEP330	Microcontrollers Lab	0-0-2	1
EEP302	Electrical Machine-II Lab	0-0-2	1	ECP320	Linear Electronic Circuits Lab	0-0-2	1
EEP305	Control System-I Lab	0-0-2	1				
ELECTIVE (Any one)				**ELECTIVE (Any one)**			
EEL327	Electrical Power Distribution System	3-0-0	3	EEL411	Flexible AC Transmission Systems [#]	3-0-0	3
EEL328	Optimization Techniques	3-0-0	3	EEL432	Computer Methods in Power System	3-0-0	3
				ELECTIVE LAB (Any one)			
				EEP411	Flexible AC Transmission Systems Lab	0-0-2	1
				EEP432	Computer Methods in Power System LAB	0-0-2	1
	Total No of Credits	**23**			**Total No of Credits**	**20**	

prerequisite

EEL203 Electrical Machine-I for Electrical Machine-II
EEL225 Electrical Power System-I for Electrical Power System-II
EEL204 Instrumentation for Industrial Automation

prerequisite

EEL226 Power Electronics for FACTS

VII Semester				VIII Semester			
CORE				**CORE**			
Code	**Course**	**L-T-P**	**Cr**	**Code**	**Course**	**L-T-P**	**Cr**
EEL402	High Voltage Engineering	3-0-0	3	EED402	Project Phase-II[#]	0-0-4	4
EEP402	High Voltage Engineering Lab	0-0-2	1	**ELECTIVE (Any four)**			
EED401	Project Phase-I	0-0-2	2	EEL416	Renewable Energy System	3-0-0	3
				EEL426	Condition Monitoring of Electric Components	3-0-0	3
				EEL427	Restructured Power systems	3-0-0	3
				EEL431	Smart grid	3-0-0	3
				EEL418	Control Systems II	3-0-0	3
ELECTIVE (Any five)				ELECTIVE LAB (Any one)			
EEL408	Advanced Power Electronics[#]	3-0-0	3	EEP433	Computer Applications in Electrical Engineering Lab	0-0-2	1
EEL409	HVDC transmission	3-0-0	3	EEP416	Renewable Energy System Lab	0-0-2	1
EEL428	Introduction to Electric Vehicles	3-0-0	3				
EEL421	Power Quality	3-0-0	3				
EEL412	DSP Applications to power System	3-0-0	3				
MEL424	Industrial Engineering & Management	3-0-0	3				
Total No of Credits		**21**		**17**			

Prerequisite

EEL226 Power Electronics for Advanced Power Electronics
EED 401 Project Phase-I for Project Phase-II

LIST OF CORE COURSES

Course Code	Subject Name	L-T-P	Credit	Prerequisite
EEL201	Network Theory	3-1-0	4	
EEL202	Signals and Systems	3-1-0	4	
EEL204	Instrumentation	3-0-0	3	
ECL206	Electronic Devices and Circuits(EDC)	3-0-0	3	
MAL201	Integral Transforms and PDE	3-0-0	3	
EEP201	Network Lab	0-0-2	1	
EEP204	Instrumentation Lab	0-0-2	1	
ECP206	Electronic Devices and Circuits LAB	0-0-2	1	
EEL203	Electrical Machines-I	3-0-0	3	
ECL207	Digital Circuits	3-0-0	3	
EEL225	Electrical Power Sytems-I	3-0-0	3	
EEL226	Power Electronics	3-1-0	4	
EEP203	Electrical Machines-I Lab	0-0-2	1	
EEP226	Power Electronics Lab	0-0-2	1	
ECP207	Digital Circuits Lab	0-0-2	1	

EEL302	Electrical Machine-II[#]	3-0-0	3	EEL203 Electrical Machines-I
EEL325	Electrical Power System-II[#]	3-1-0	4	EEL225 Electrical Power Systems-I
EEL326	Industrial Automation[#]	3-0-0	3	EE204 Instrumentation
EEL305	Control System-I	3-1-0	4	
EEL307	Electrical Machine Design	3-0-0	3	
EEP326	Industrial Automation	0-0-2	1	
EEP302	Electrical Machine-II Lab	0-0-2	1	
EEP305	Control System-I Lab	0-0-2	1	
EEL304	Electric Drives & Their Control	3-1-0	4	
EEL329	Switchgear and Protection	3-0-0	3	
EEL330	Micro Processors& Micro Controllers	3-0-0	3	
ECL320	Linear Electronic Circuits	3-0-0	3	
EEP329	Switchgear and Protection Lab	0-0-2	1	
EEP330	Micro Processors& Micro Controllers Lab	0-0-2	1	
ECP320	Linear Electronic	0-0-2	1	

	Circuits Lab			
EEL402	High Voltage Engineering	3-0-0	3	
EEP402	High Voltage Engineering Lab	0-0-2	1	
EED401	Project Phase-I	0-0-2	2	
EED402	Project Phase-II[#]	0-0-4	4	EED401 Project Phase-I

LIST OF ELECTIVE COURSES

Course Code	Subject Name	L-T-P	Credit	Prerequisite
EEL206	Elements of Electromagnetic	3-0-0	3	
PHL202	Introduction to Material Science	3-0-0	3	
EEL215	Electrical Power Utilization	3-0-0	3	
EEL227	Power Station Practice	3-0-0	3	
MAL205	Numerical Methods & Probability Theory	3-0-0	3	
EEP223	Programming Techniques and Simulation Lab	0-0-2	1	
EEP306	Electrical Workshop lab	0-0-2	1	
EEL327	Electrical Power Distribution System	3-0-0	3	

EEL328	Optimization Techniques	3-0-0	3	
EEL411	FACTS #	3-0-0	3	EEL226 Power Electronics
EEL432	Computer Methods in Power System	3-0-0	3	
EEP411	FACTS LAB	0-0-2	1	
EEP432	Computer Methods in Power System LAB	0-0-2	1	
EEL408	Advanced Power Electronics#	3-0-0	3	EEL226 Power Electronics
EEL409	HVDC	3-0-0	3	
EEL428	Introduction to Electric Vehicles	3-0-0	3	
EEL421	Power Quality	3-0-0	3	
EEL412	DSP Applications to power System	3-0-0	3	
MEL424	Industrial Engineering & Management	3-0-0	3	
EEL416	Renewable Energy System	3-0-0	3	
EEL426	Condition Monitoring of Electric Components	3-0-0	3	
EEL427	Restructured Power systems	3-0-0	3	
EEL431	Smart grid	3-0-0	3	

EEL418	Control Systems II	3-0-0	3	
EEP433	Computer Applications in Electrical Engineering lab	0-0-2	1	
EEP416	Renewable Energy System lab	0-0-2	1	

LIST OF OPEN COURSES (OFFERED BY THE DEPARTMENT)

Course Code	Subject Name	L-T-P	Credit	Prerequisite
EEL417	Energy Conservation & Audit	3-0-0	3	
EEL272	Advance course in Electrical Engg	3-0-0	3	
EEL416	Renewable Energy Systems	3-0-0	3	
EEL381	Industrial Electrical Engg.	3-0-0	3	

FIRST SEMESTER

EEL101: BASIC ELECTRICAL ENGINEERING (3-1-0 Credits -4)

Objectives:

- ***To learn basic ideas and principles of Electrical Engineering.***
- ***Understanding of details of electrical power systems, transformers, generators and motors.***

Syllabus:

Electrical Circuit**:-** Circuit Elements Resistance, Inductance & Capacitance, Kirchhoff's Laws, Voltage Source (Definition, Characteristics of Practical Source, and Equivalent Current Source), and Star-Delta Transformation

Magnetic Circuit**:-** Flux, MMF, Reluctance, Analogy with Electric Circuits. Simple Calculations for Composite Magnetic Circuits

AC Circuits **:-**Periodic Function, Average & R.M.S., Values, Steady State Behavior With Sinusoidal Excitation, Phasor Representation, Reactance & Impedance, Series & Parallel Circuit, Power Factor, Principle of Generation of Single Phase & Three Phase Voltages, Power in Balanced Three Phase AC System

Electrical Measurements**:-** Definition, Indicating, Integrating & Recording Instruments, Deflecting Controlling & Damping Mechanisms, Ammeter & Voltmeters, P.M.M.C. Type & Moving Iron Type, Electrodynamometer Type Wattmeter, Induction Type Single Phase Energy Meter

Transformers**:-** Introduction, Basic Principles, Construction, Phasor Diagram for Transformer under No Load Condition Transformer on Load, Balance of MMF on Sides, Phasor Diagram, Equivalent Circuit, Voltage Regulation and Efficiency

Power Systems**: -** Elementary Idea about Power Generation, Transmission and Distribution

Electric Machines**: -** DC Shunt and Series Motor – Construction, Principle of Working, Characteristics, Speed Control and Applications

Induction Motors**:-**Construction, Principle of Working of Single Phase and 3-Phase Motors. Torque Slip Characteristics

Basic issues involved in electrical hazard and electrical safety.

Text Books:

1. Vincent Del Toro, "Electrical Engineering Fundamentals", PHI Learning Pvt Ltd ,
2. S.K. Bhattacharya , "Basic Electrical and Electronics Engineering", Pearson Education, 2012

Reference Books

3. O.I. Elgerd, "Basic Electric Power Engineering", Addison Wesley Longman
4. Kothari D.P. and Nagrath I.J., "Theory And Problems of Basic Electrical Engineering," Prentice Hall
5. Edward Hughes, "Electrical Technology", Pearson Education , 2008
6. Basic Electrical Engineering – A Web course of NPTEL by Day, Bhattacharya & Roy, *Available*:- www. nptel.ac.in
7. Fitzgerald, Higginbotham and Gabel, "Basic Electrical Engineering", McGraw Hill

Course Outcomes:

Students are able to

1. ***Understand basics of R , L , C circuit elements and voltage and current sources.***
2. ***Appreciate and analyze DC , AC and magnetic circuits using KVL and KCL.***
3. ***Understand working principle of various analogue electrical measuring instruments.***
4. ***Comprehend the working of DC machines, transformers and induction Motors.***

EEP101: BASIC ELECTRICAL ENGINEERING LAB (0-0-2 Credits-1)

List of Experiments:

1. Study and verification of Kirchhoff's Laws applied to direct current circuit.
2. Determination of B/H curve of a magnetic material
3. Study of AC series circuits.
4. Study of AC Parallel circuits.
5. To study balanced three phase circuit.
6. Determine Voltage regulation and efficiency of a single phase transformer by direct loading.
7. Speed control of a DC motor by varying :-
    a. field current with armature voltage kept constant
    b. armature voltage with field current kept constant.
8. Reversal of direction of rotation of a three phase induction motor.

THIRD SEMSESTER

EEL201: NETWORK THEORY (3-1-0-Credits -4)

Objectives:

- ***The subject deals with the various methods of analysis of electrical circuits under transient and steady state conditions.***
- ***It provides a solid foundation for later learning as well as for future professional activities.***

Syllabus:

Node and Mesh Analysis: Node and mesh equation, matrix approach of complicated network containing voltage and current sources, and reactances, source transformation, Graph Theory and network equations and duality.

Network theorem: Superposition, Reciprocity, Thevenin's, Norton's, Maximum Power Transfer, Compensation and Tellegen's theorem as applied to AC circuits.

Laplace transforms and properties: Partial fraction, singularity functions, waveform synthesis, analysis of RC, RL, and RLC networks with and without initial conditions with Laplace transforms evaluation of initial conditions.

Transient behavior, concept of complex frequency, Driving points and transfer functions poles and zeros of admittance function, their properties, sinusoidal response from pole-zero locations, convolution theorem and integral solutions.

Text Books:

1. Van Valkenburg, "Network Analysis", Third Edition, 2009, Prentice Hall of India.
2. Sudhakar, A. Shyammohan, "Circuits and Network", Third Edition, 2006, Tata McGraw-Hill.

Reference Books:

1. Kelkar and Pandit, "Linear Network Theory", Pratibha Publication.
2. Mahmood Nahvi, Joseph A Edminister, "Schaum's Outline of Electric Circuits", 6th edition, Tata McGraw-Hill.

Course Outcomes:

Students are able to

1. ***Understand basics electrical circuits with nodal and mesh analysis.***
2. ***Appreciate electrical network theorems.***
3. ***Apply Laplace Transform for steady state and transient analysis.***
4. ***Determine different network functions.***

EEP201: NETWORK THEORY LAB (0-0-2- Credits-1)

List of experiments:

1. Study of 3-phase, Star connected, Unbalanced circuit.
2. Verification of Maximum Power Transfer Theorem
3. Verification of Superposition Theorem.
4. Verification of Reciprocity Theorem.
5. Determination of Two port parameters of given network.
6. Study of 3-phase, Delta connected, Unbalanced circuit.
7. Verification of Thevenin's and Norton's Theorem.
8. Study of Series and Parallel Resonance.

Note: The experiments are to be conducted for AC networks.

EEL202: SIGNALS AND SYSTEMS (3-1-0-Credits -4)

Objectives:

- ***The subject deals with various methods of analysis for continuous time and discrete time systems in time domain and frequency domain.***
- ***Being a basic course, students need to master this subject well and associate its basic concepts in order to become competent engineers.***

Syllabus:

Elements of Signal Space Theory: Different Types of Signals, Linearity, Time Invariance and Causality, Impulse Sequence, Impulse Functions and Other Singularity Functions.

Convolution: Convolution Sum, Convolution Integral and Their Evaluation, Time Domain Representation and Analysis, of LTI Systems Based on Convolution and Differential Equations.

Multi Input-Output Discrete and Continuous Systems: State Model Representation, Solution of State, Equations, State Transition Matrix.

Transform Domain Considerations: Laplace Transforms and Z-Transforms, Application of Transforms to Discrete and Continuous Systems Analysis, Transfer Function, Block Diagram Representation, and DFT.

Fourier series and Fourier Transform: Sampling Theorem, Discrete Fourier Transform (DFT), Estimating Fourier Transform Using (DFT).

Text Books:

1. Oppenheim A.V., Willsky A.S. and Young I.T., "Signals and Systems", Second Edition,1997,Prentice Hall.
2. Simon Haykin and Barry Van Veen, "Signals and Systems", Second Edition, Wiley International.

Reference Books:

1. R.F. Ziemer, W.H Tranter and J.D.R.Fannin, "Signals and Systems - Continuous and Discrete", Forth Edition Prentice Hall.
2. M. J. Roberts, "Signals and Systems",2003, Tata McGraw-Hill.

Course Outcomes:

Students are able to

1. ***Know basics of signal space theory.***
2. ***Understand convolution sum of two signals.***
3. ***Appreciate the concepts of state space representation.***
4. ***Apply different transform for discrete and continuous analysis.***

EEL204: INSTRUMENTATION (3-0-0- Credits-3)

Objectives:

- ***Understand the necessity and importance of instrumentation.***
- ***To know about all kinds of sensors and transducers.***
- ***To learn to apply proper sensor in instrumentation.***

Syllabus:

Introduction: Basic concepts and recent developments, role of instrumentation in industrial-automation, general characteristics and response of measuring systems. The concepts of accuracy and precision and sources of measurement Errors.

Sensors and Transducers: Classification, selection and applications. Sensor characteristics; R, L and C sensors: Hall effect sensors; Piezoelectric sensors; Micro-sensors. Sensors for displacement, pressure, temperature, flow etc. Optical sensors; chemical and bio-sensors. Sensor applications in non-destructive testing. Interfacing sensors with microprocessors and micro controllers. Digital Transducers: Types and applications.

Current probes and their efficiency. Filter designs and concepts of operating bandwidth. Digital instrumentation in power application, A/D and D/A circuits and their operation. Basic concepts of digital filtering storage and related circuit design. Microprocessors in power instrumentation, configuration and software flowcharts for basic power measurement involving filtering, arithmetic operations and storage.

Signal Conditioning: Requirements, OP-AMP based Instrumentation circuits. Bridges, Instrumentation amplifiers. Digital Signal Conditioning: Data converters: A/D and D/A conversion, data loggers, microprocessor based data acquisition systems. Telemetry systems: Analog and digital systems.

Examples of advanced instrumentation: oscilloscopes and spectrum analyzers. Data Acquisition and computer control. Interfacing with microcontrollers and personal computers. Virtual (Software) instrumentation.

Text Books:

1. Ernest O. Doebelin, "Measurement Systems Application and Design, International Student Edition", McGraw Hill Book Company, 1998.

2. Alan S. Morris, Reza Langari, "Measurement and Instrumentation: Theory and application", Academic Press, 2012.

Ref Books:

1. D. V.S.Murthy, "Transducers in instrumentation", Prentice Hall, 1995.
2. D.Patranabis, "Principles of Industrial Instrumentation", Tata McGraw Hill Publishing Ltd., New Delhi, 1999.
3. B.C.Nakra and K.K.Chaudhary, "Instrumentation Measurement and Analysis", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1985.
4. David A Bell, "Electronic Instrumentation and Measurements", Prentice Hall of India, New Delhi, 2006.

Course Outcomes:

Students are able to:-

1. ***Appreciate various aspects of the art and science of instrumentation***
2. ***Know about different kinds of sensors and transducers.***
3. ***Apply idea about signal processing, DAS etc.***
4. ***Apply proper sensors and transducer for the specific application.***

EEP204: INSTRUMENTATION LAB (0-0-2- Credits -1)

List of experiments:

1. Measurement of low resistance by Kelvin double bridge.
2. Measurement of medium resistance by ammeter voltmeter method
3. To study polarity marking of current transformers.
4. Measurement of three phase power by two wattmeter method.
5. To study the characteristics of pressure cell with respect to signal conditioned output voltage.
6. To study and plot characteristics of LVDT.
7. To study the characteristics of developing torque and signal conditioned sensor output voltage.
8. Testing of poly-phase energy meter by direct loading.

ECL206: ELECTRONIC DEVICES & CIRCUITS (3-0-0- Credits-3)

Objectives:

- ***To introduce students with the various concepts of electronic devices and circuits.***
- ***To teach the theory of various types of diodes, transistors, amplifiers, oscillators etc.***

Syllabus:

Semiconductor Physics, P &N Type Semiconductors, Diodes and Power Supplies, Theory of P-N Junction Diode, Junction Capacitance, Characteristics & Applications of Following Diodes, Zener, Schottkey, Photodiode, LED, LCD, Varactor Diode &Tunnel Diode

Power Supplies, Halfwave & Fullwave, Rectifiers, Filters, Ripple-Factor, Zener & Emitter Follower Type Regulators

Junction Transistors Theory of Operation, Static Characteristics , Break Down Voltages, Current Voltage Power Limitations, Biasing of BJT Different Biasing Arrangements, Stability Factor, Thermal Runaway, Power Transistors

Small Signal Analysis & High Frequency Analysis of BJT CE, CB, CC Amplifiers and Comparison High Frequency Analysis Calculation of Frequency Response, Gain Bandwidth Product

Power Amplifiers Classification A, B, AB, C Classes, Efficiency, Push Pull Configuration, Complimentary Symmetry, Second Harmonic & Cross Over Distortion. Positive and Negative Feedback Amplifiers Classification, Practical Circuits, Applications, Advantages. Oscillators Stability, Barkhausen Criteria, RC, LC & Crystal Oscillators

Field Effect Transistor & MOSFET, Principle of Operation & Characteristic, Biasing Arrangement, Small Signal Analysis of CG, CD & CS, High Frequency Analysis

Text Books:

1. Milman and Halkias, "Integrated Electronics", Second Edition, 2011, McGraw Hill.
2. Bapat, "Theory & Problem in Circuit analysis", McGraw Hill.

Reference Books:

1. Boylestad and Nashelsky, "Electronic Devices & Circuit theory",2011, Tenth Edition, Dorling Kindersley (RS).
2. Schilling & Belove, "Electronic Circuits - Discrete and Integrated", Third Edition, McGraw Hill.
3. Carr, "Electronic Devices", Tata McGraw Hill.
4. I.J. Nagrath, "Electronics - Analog and Digital", First Edition, 2009, PHI.

Course Outcomes:

Students are able to

1. ***Understand basics electronic circuits.***
2. ***Appreciate concepts of small signal analysis.***
3. ***Comprehend the operation of different power amplifier.***
4. ***Know high frequency analysis.***

ECP206: ELECTRONIC DEVICES & CIRCUITS LAB (0-0-2- Credits-1)

List of Experiments:

1. To plot V-I Characteristics of diode and compare various parameters (both in forward and reverse bias)
2. To study zener diode as a voltage regulator & plot its load regulation characteristics.
3. To study full wave rectifier with & without filters and compare the ripple factor theoretically and practically.
4. To draw input/ output characteristics of common emitter configuration and compute the h-parameters.
5. To study JFET characteristics and compute various parameters.
6. To study and plot the frequency response of single stage BJT amplifier.
7. To study RC phase shift oscillator using BJT.

MAL201: INTEGRAL TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS (3-0-0-Credits-3)

Objectives:

- ***To teach various mathematical transforms.***
- ***Study of partial differential equations.***

Syllabus:

Laplace Transforms: Definition of Laplace Transforms, Linearity Property, Condition For Existence of Laplace Transform, First and Second Shifting Properties, Transforms of Derivatives and Integrals, Evaluation of Integrals by Laplace Transform. Inverse Laplace Transform, Convolution Theorem, Laplace Transform of Periodic Functions, Unit Step Function and Dirac Delta Function. Applications of Laplace Transform to Solve Ordinary Differential Equations

Fourier series and Fourier Transforms: Fourier series, Half Range Sine and Cosine Series Expansions, Exponential Form of Fourier Series. Fourier Integral Theorem, Fourier Transform, Fourier Sine and Cosine Transforms, Linearity, Scaling, Frequency Shifting and Time Shifting Properties, Convolution Theorem

Z-Transform: Z - Transform, Properties of Z-Transforms, Convolution of Two Sequences, Inverse Z-Transform, Solution of Difference Equations

Partial Differential Equations: Formation of First and Second Order Equations, Solution of First Order Linear Equations: Lagrange's Equation, Particular Solution Passing through a Given Curve. Higher Order Equations with Constant Coefficients, Classification of Linear Second Order Poles, Method of Separation of Variables, Solution of one Dimensional Wave Equation, Heat Equation, Laplace Equation (Cartesian And Polar Forms), D'Alembert Solution of Wave Equation

Text Books:

1. Kreyszig, E. John, "Advanced Engineering Mathematics", Eighth Edition, 1999, Wiley & Sons.
2. R.K. Jain and S.R.K Iyengar, "Advanced Engineering Mathematics", Third Edition, 2007, Narosa Publishers.

Reference Books:

1. G.B. Thomas and R.L Finney, "Calculus and Analytic Geometry", Addison Wesley Longman Inc.

Course Outcomes:

Students are able to

1. ***Apply Laplace transform to solve differential equations.***
2. ***Understand theory and application of Fourier transform.***
3. ***Know basics of Z-Transform.***
4. ***Solve partial differential equations.***

EEL206: ELEMENTS OF ELECTROMAGNETICS (3-0-0- Credits-3)

Objectives:

- ***To learn the fundamental concepts applied in Electrostatics, Magnetostatics, Time-varying fields and Electromagnetic Waves.***
- ***To apply the principles of Electromagnetic Field Theory for the design and analysis of Power Transmission lines.***

Syllabus:

Vector Algebra, Cartesian, Cylindrical and Spherical Co-ordinate System. Transformation of Variables from Cartesian to Cylindrical and Spherical Coordinate System and Vice-Versa

Coulomb's Law, Electric Field Intensity, Field of 'N' Point Charges, Field of Line and Sheet of Charge, Electric Flux Density, Gauss's Law and Its Applications, Divergence and Divergence Theorem

Definition of Potential Difference and Potential, Potential of Point Charge and System of Charges Potential Gradient, Energy Density in Electrostatic Field. Poisson's and Laplace's Equations, Current and Current Density, Continuity of Current Capacitance, Dielectrics.

Biot-Savart, Amperes Circuital Laws and their Applications, Curl, Stoke's Theorem, Magnetic Flux Density, Scalar and Vector Magnetic Potential, Maxwell's Equations in Steady Electric and Magnetic Fields

Force on Moving Charge and Differential Current Element, Force and Torque on a Closed Circuit. Time Varying Fields and Maxwell's Equations ,.

Transmission Lines

Uniform Plane Waves, Wave Motion in Free Space, Perfect Dielectric, Lossy Dielectric and Good Conductor, Skin Effect, PoyntingVector and Power Considerations. Reflection of Uniform Plane Waves, Standing Ratio

Text Books:

1. Hayt W.H., "Engineering Electromagnetics", 2013, Eighth Edition, Tata Mc-GrawHill.
2. Mathew, N.O. Sadiku, "Elements of Electromagnetics", Fourth Edition, Oxford University Press.

Reference Books:

1. N. Narayan Rao, "Elements of Engineering Electromagnetics", Sixth Edition,2006, Pearson Education.

Course Outcomes:

Students are able to

1. ***Understand basics of electromagnetic circuits.***
2. ***Grasp concepts of magnetostatics.***
3. ***Comprehend knowledge of time varying fields.***
4. ***Appreciate basics of electromagnetic waves.***

PHL202: INTRODUCTION TO MATERIAL SCIENCE (3-0-0-Credits -3)

Objectives:

- ***To learn in depth about electrical and magnetic properties of materials.***
- ***To study properties of dielectric and semiconductor materials.***

Syllabus:

Electrical Conduction : Electronic and Ionic Conduction , Conductivity in Metals , Ohm's Law , Relaxation Time , Collision Time , Mean Free Path of an Electron , Electron Scattering , Resistivity of Metals , Effect of Temperature and Impurity on Conductivity , Joule's Law , High Conductivity And Resistivity Materials , Superconductivity and Applications

Polarization of Dielectrics : Polar and Non-Polar Dielectrics , Basic Concept of Polarization , Types of Polarization, Dielectric Constant ,Internal Field in Dielectrics , Ferroelectric ,Spontaneous Polarization, Curie-Weiss Law, Piezoelectric and Pyroelectric , Dielectric Loss , Breakdown in Dielectrics, Dielectric in Alternating Field : Dielectric Properties of Insulators in Alternating Fields, Complex Dielectric Constant , Electronic Polarization , Ionic Polarization , Frequency Dependence of Electronic Polarization, Dielectric Constant of Non-Polar Solids , Dipolar Relaxation , Loss Tangent

Magnetic Properties of Materials: Atomic Interpretation of Diamagnetic, Paramagnetic, Anti-Ferromagnetic and Ferromagnetic Materials. Ferromagnetic Domain , Alloy for Core Materials for Rotating Machines , Transformers , Permanent Magnets and Non Magnetic Steels , Nonmetallic Magnetic Materials , Thin Film Magnets , Magnetic Materials for Ferromagnetic Tape And Memory Devices

Semiconductor Material Technology: Method for Material Preparation, Purification and Doping, Introduction to Processes of Manufacturing Semiconductor Devices, Transistors, Integrated Circuits .Monolithic Diodes, Integrated Resistors and Integrated Capacitor.

Text Books:

1. Dekkar, A.J., "Electrical Engineering Materials, Reprint Edition", 2009, Prentice Hall Publications Co.
2. Kasap S.O., "Principle of Electronic Materials and Devices", Second Edition, Tata McGraw- Hill.

Reference Books:

1. S.O Pillai., "Solid State Physics", Third Edition, New Age International Publishers.

Course Outcomes:

Students are able to

1. ***Grasp the basics of electrical properties of material.***
2. ***Understand the concepts of magnetic properties of material.***
3. ***Know about semiconductor material technology.***
4. ***Appreciate the concepts of dielectrics.***

FOURTH SEMESTER

EEL203: ELECTRICAL MACHINES-I (3-0-0- Credits-3)

Objectives:

- ***To learn the basic operation and control of DC machines.***
- ***To learn transformer operation w.r.t. harmonics and connections.***
- ***To study the Induction motor***

Syllabus:

Winding**:** Types of Windings of DC and AC Machine, MMF of winding and induced EMF
.
D.C. Motor**:** Basic Principle and Operation, Classification, Armature Reaction and Commutation, Inter-pole and Compensating winding, Torque, Characteristics, Starting, Speed Control, Braking, Permanent Magnet Machines, Losses, Efficiency, Testing, Applications.

Three Phase Transformer**:** Connection and Phasor Groups, Effect of Polarity Marking and Phase Sequence, Parallel Operation, Excitation Phenomenon and harmonics, Tertiary Winding, Unbalanced Operation, Single Phasing, Open Delta Connection, Testing of Transformer Bank for Proper Connection, Scott Connection, Tap Changing Transformer, Cooling of Transformer, Applications.

Three Phase Induction Motor**:** Principle and Operation, Classification, Torque Speed Characteristics.

Single Phase Induction Motor**:** Principle and Operation, Types, Equivalent Circuit, Characteristics, Applications.

Text Books:

1. A. E.Fitzgerald, Charles Kingsley, Jr. Stephen D. Umans, "Electric Machinery", Fifth Edition, Tata McGraw-Hill
2. I. J. Nagrath, , D. P.Kothari, "Electric Machines", Third Edition, Tata McGraw-Hill Publishing Company Ltd.

Reference Books:

1. P. S. Bhimbra, "Electrical Machinery", Seventh Edition, 1995,Khanna Publishers.
2. P. S. Bhimbra, "Generalized Theory in Electrical Machines", Khanna Publishers.
3. P. K. Mukharjee, S Chakravarti, "Electric Machines", Dhanpat Rai & Sons.

Course Outcomes:

Students are able to

1. ***Appreciate and understand DC machines***
2. ***Comprehend the operation and performance of three-phase transformer***
3. ***Appreciate the operational principle of three-phase induction motor.***

EEP203: ELECTRICAL MACHINES-I LAB (0-0-2-Credits -1)

List of experiments:

1. To study the various configurations of three-phase transformer
2. To study the speed control of DC Shunt Motor by a) varying armature voltage with field current kept constant, b) varying field current with armature voltage kept constant.
3. To perform Load Test on DC Shunt Generator.
4. To perform O. C. and S. C. Test on a Single Phase Transformer
5. To study the **a)** Polarity Markings on Single Phase Transformer Windings and to study **b)** Autotransformer.
6. To study the Load Test on a D C Cumulatively Compounded Motor.
7. To study the Load Test on a 3-Phase Induction Motor.
8. To determine Voltage Regulation and Efficiency of a Single Phase Transformer by Direct Loading.
9. To Study Scott-Connection of Transformers (Three Phase to Two Phase Conversion).

Reference Book:

1. D. P. Kothari, B. S. Umre, "Laboratory Manual for Electrical Machines", IK International New Delhi.

ECL207: DIGITAL CIRCUITS (3-0-0-Credits -3)

Objectives:

- ***Study of various number systems and logic gates.***
- ***Study of flip-flops, counters, encoders, decoders, multiplexers etc.***

Syllabus:

Analog Vs. Digital Systems, Transistor as a Switch, Boolean Identities, Logic Problems, Binary, Gray, Octal, Hex and ASCII Codes, Gates And Their Truth Tables, De Morgans Law, Sum of Products And Product of Sums.

Combinational Basic Concepts, SSI, MSI, VLSI Circuit Classification, Standard TTL, CMOS Characteristics, Decoders, Encoders, Multiplexers, Code Converters Characteristics of Display Devices, Standard Configuration of Gates As SSI/MSI/LSI Circuits, Arithmetic Circuits-Adders, Subtractors (Half And Full) BCD Adder/Subtractor, Concept of ALU.

Karnaugh Map, Simplification of Sum of Products and Product of Sums, Solution to Problems Using MUX as A Function Generator, Simplification of Logical Functions Using Quine-Mclausky Method.

Introduction To Flip-Flop, Latches, Concept of Clock, Memoir Organization With Flip-Flop as Basic Cell, RAM, ROM, EPROM, EEPROM, An Overview, Master Slave Combination and Conversion of One Type To Another Type Flip-Flops, Multi-Vibrators and Their Design Parameters.

Execution Tables and Introduction to Sequential Circuits, Counters, Synchronous / Asynchronous, Different Module Counters with Reset/Clear Facility, Design of Counters of Arbitrary Module with K-Maps, Lock Free Counters

Introduction to Sequential System, Design of Sequential System Using Moore and Miley System, Fundamental Mode Sequential Circuits.

Text Books:

1. H.Taub, "Digital Integrated Electronics", First Edition,2008, McGraw Hill.
2. Anand Kumar, "Fundamentals of Digital Circuits", Second Edition,2009, PHI.

Reference Books:

1. R.P.Jain,"Digital Logic Design", First Edition, 2003, PHI.
2. Malvino, Leach, "Digital Principles and Applications", Sixth Edition, 2006, McGraw Hill.

Course Outcomes:

Students are able to

1. ***Know the conversion of number system.***
2. ***Understand the concept of combinational circuits.***
3. ***Comprehend the basic of sequential circuits.***
4. ***Design counters.***

ECP207: DIGITAL CIRCUITS LAB (0-0-2- Credits-1)

List of experiments:

1. Study of logic gates.
2. Implementation of basic gates using universal gates.
3. Implementation of formula F=∑(0,1,4,5,6,8,9,12,13,14) using NAND gate only.
4. To study the half adder and full adder.
5. To study the MUX and DEMUX.
6. To study the encoder and decoder.
7. To study of JK, D, T flip flops.
8. Study of counters.
9. Study of shift registers.

EEL225: ELECTRICAL POWER SYSTEM-I (3-0-0-3)

Objectives:

- ***Modeling of transmission lines***
- ***Appreciate use of PU quantities in power system analysis***
- ***Obtain Steady state solution of power system using G-S Load Flow***
- ***Study Effect of P/Q on V/F***

Syllabus

General Structure of Electrical Power System- Introduction to Power System, Generation, Transmission, Distribution and Utilization- Overview Single Line Diagram (SLD) Representation

Transmission Substations- Different Types of Transmission Substations, Idea About Substation and Equipments in Substation, Radial and Grid Systems, Concept of Instantaneous, Real, Reactive and Complex Power, Three Phase Power and Power Loss.

Transmission Lines- Types of Transmission Lines, Basic Concept of Inductance and Capacitance of Transmission Lines, Modes of Short, Medium, Long Transmission Lines, A, B, C, D Parameters, Transmission Line Voltage Control Methods

Per Unit System- Necessity, Advantages, Applications in Power Systems and Calculations

Load Flow Analysis- Y Bus Formation, Gauss Iterative and Gauss Seidal Method, Method for Solution of Load Flow Problem (Not More Than 3 Buses) MATLAB Program

Control Model- Load Frequency Control, Model of Turbine Speed Governing System, Load Sharing By Generators, Concept Of Control Area, Two Area Load Frequency Control, Model of Automatic Voltage Regulator (AVR), Voltage Behind Reactance Model of Generator and Power Angle Characteristics.

Text Books:

1. W.D. Stevenson Jr., Elements of power system analysis, McGraw-Hill publications, 3rd Edition
2. I.J. Nagrath, D. P. Kothari, Power System Engineering, Tata McGraw-Hill publications,2008

Reference Books:

1. Prabha Kundur, Power System Analysis and Control, TMH, 2008
2. O. I. Elgerd, Electric Energy Systems Theory, McGraw-Hill publications 1971
3. John J Grainger, W.D. Stevenson, Power System Analysis, McGraw-Hill (India) Pub. , 2003
4. Hadi Saadat, Power System Analysis , TMH , 2002

Course Outcomes:-

Students should be able to:

1. ***Calculate receiving end voltage of a given transmission line***
2. ***Calculate currents and voltages in various parts of power system using PU concept***
3. ***To find voltage at all buses and power flow through all lines given the loads and generation***

EEL226: POWER ELECTRONICS (3-1-0-Credits -4)

Objectives:

- ***To learn different power semiconductor devices.***
- ***To learn different converter topologies, their operation and applications.***

Syllabus:

SCR and its Characteristics, Series and Parallel Connections of SCRs, Protection Circuit Design, Line Commutated Converters: Working of Single Phase, Three Phase Bridge Converters. Effect of Source Inductance in Converters, Speed Control of DC Motor using Converter.

AC Voltage Controllers, Cyclo-Converters (Single Phase)

Static Controllable Switches**:** Characteristics and Working of MOSFET. Gate Turn off Thyristor and Insulated Gate Bipolar Transistor.

D.C Choppers**:** Classification, Buck, Boost, Buck-Boost, CCM, DCM modes of operation, Application of Choppers.
Single Phase and Three Phase Bridge Inverters: Output Voltage Control, Harmonics in Output Voltage Waveform,
Harmonics Attenuation by Filters, Harmonic Reduction by Pulse Width Modulation Techniques concept of SVPWM. Working of Current Source Inverters, few Applications of Inverters, Principle of Resonant Inverter

Text Books:

1. M. Rashid, "Power Electronics", Pearson Education India, 2004.
2. Ned Mohan, "Power Electronics", Third Edition, 2012, John Willey.

Reference Books:

1. M.D. Singh, K.B. Khanchandani, "Power Electronics", Tata McGraw Hill.
2. C.Y. Lander., "Power Electronics", Third Edition, 1993, McGraw Hill International.
3. B.K .Bose, "Modern Power electronics", 2003,Pearson Education India.
4. Joseph Vithyathil, "Principles of Power Electronics", First Edition, 2010,Tata McGraw Hill.

Course Outcomes:

Students are able to

1. ***Know concepts of semiconductor switches.***
2. ***Understand operation and applications of different power electronic converters.***
3. ***Appreciate working of PWM techniques.***
4. ***Comprehend operation of inverter.***

EEP226: POWER ELECTRONICS LAB (0-0-2- Credits-1)

List of experiments:

1. To study the V-I , It characteristics of SCR.
2. To study DC circuit breaker using SCR.
3. To study phase control AC-DC converter using SCR.
4. To study the relaxation oscillator using UJT.
5. Simulation of i) Single phase half wave rectifier.
    i. ii) Single phase full wave fully controlled rectifier [R, R-L, R & high L].
6. To study four modes of operation of TRIAC
7. To study AC Voltage regulator using SCR/TRIAC.
8. To study single phase inverter using self controlled devices as IGBT/MOSFET (single PWM,
9. Multiple PWM, Sinusoidal PWM)
10. To study the Three phase inverter.
11. To study DC-DC converter i) Buck converter ii) Boost converter.
12. Simulation of following experiments using PSIM
    i. AC Voltage regulator using SCR
    ii. Single phase inverter using self controlled devices as IGBT/MOSFET (Single PWM, Multiple PWM, sinusoidal PWM)
    iii. Three phase inverter.
    iv. DC-DC converter **:**
        a. Buck converter.
        b. Boost converter.

EEL215: ELECTRICAL POWER UTILIZATION (3-0-0-Credits-3)

Objectives:

- ***To enable the students to understand the concepts of electrical heating, welding, illumination, traction and their uses in industry.***

Syllabus:

Electrical Traction : Features of an Ideal Traction System, Systems of Electrical Traction, Mechanism of Train Movement, Speed- Time Curve, Traction Supply System, Transmission Line to Substation, Feeding and Distribution System on an AC Traction, System of Current Collection, Traction Motors, Tractive Effort and Horse Power, Speed Control Schemes, Electric Braking

Electric Heating: Classification, Heating Element, Losses in Oven and Efficiency, Resistance Furnace, Radiant Heating, Induction Heating, High Frequency Eddy Current Heating, Dielectric Heating, Arc Furnace, Heating of Furnace, Electric Welding, Methods and Equipments, Electrolysis and Electroplating Applications

Illumination: Radiant Energy, Terms and Definitions, Laws of Illumination, Polar Curves, Photometry, MSCP, Integrating Sphere, Luminous Efficacy, Electrical Lamps, Design of Interior and Exterior Lighting Systems, Illumination Levels for Various Purposes, Light Fittings, Factory Lighting, Flood Lighting, Street Lighting, Energy Conservation in Lighting

Air Conditioning and Refrigeration: Control of Temperature, Protection of Motors, Simple Heat-Load and Motor Calculations, Air Conditioning, Functioning of Complete Air Conditioning System, Type of Compressor Motor, Cool Storage, Estimation of Tonnage Capacity and Motor Power, Technology of Electric and Hybrid Electric Vehicles

Basics of Domestic Electrical Wiring, Types of Cables, Flexible Wires Sizes and Current Capacity, Use of Fuse, MCB and MCCB (Working and Construction), Basics of Air Flow for No Fans in a Room.

Text Books:

1. Taylor E. Openshaw, "Utilization of Electrical Energy", 1968, Orient Longman.
2. Gupta J. B., "Utilization of Electric Power and Electric Traction", 2002,S. K. Kataria and Sons

Reference Books:

1. Garg and Girdhar, "Utilisation of Electric Energy" 1982, Khanna Publisher.
2. S.C.Tripathy, "Electric Energy Utilization and Conservation",1993, Tata McGraw Hill.
3. Wadhwa C.L., "Generation, Distribution and Utilization of Electrical Energy",1993, Wiley Eastern Limited,
4. Pratab H., "Art and Science of Utilization of Electrical Energy", Second Edition, Dhanpat Rai and Sons, New Delhi.
5. Web Resources :- Bee-india.org. ,eia.doe.gov. , www.irfca.org. , IEEE bronze book- IEEE Press.

Course Outcomes:
Students are able to

1. ***Understand the working of traction system.***
2. ***Know the properties of different electric heating system.***
3. ***Grasp the detail idea of effective power utilization.***
4. ***Comprehend basic domestic electric wiring.***

EEL227: POWER STATION PRACTICE (3-0-0-Credits-3)

Objectives:

- ***To learn the details of operations of various power plants.***

Syllabus:

Conventional Sources of Electrical Energy - Steam, Hydro, Nuclear, Diesel and Gas; Their Scope and Potentialities for Energy Conversion

Generation – Different Factors Connected With a Generating Station; Load Curve, Load Duration Curve, Energy Load Curve; Base Load and Peak Load Plants.

Thermal Stations – Selection of Site, Size and Number of Units, General Layout, Major Parts, Auxiliaries, Generation Costs Of Steam Stations.
Hydro Stations – Selection of Site, Mass Curve, Flow Duration Curve, Hydrograph, Classification of Hydro Plants, Types of Hydro Turbines, Pumped Storage Plants.
Nuclear Stations – Main Parts, Location, Principle of Nuclear Energy, Types of Nuclear Reactors, Reactor Control, Nuclear Waste Disposal.
Power Station Control and Interconnection – Excitation Systems, Excitation Control, Automatic Voltage Regulator Action; Advantage of Interconnection
Alternate Energy Sources Overview

Text Books:

1. M.V. Deshpande, "Elements of Electrical Power Station Design", 2010, PHI.
2. B.R. Gupta, "Generation of Electrical Energy", 2003, Eurasia Publishing house.

Reference Books:

1. Arora and Domkundwar, "A Course in Power Plant Engineering", 1988, Dhanpat Rai and Sons.
2. M.M. El-Wakil, "Power Plant Technology", 1985, McGraw- Hill.

Course Outcomes:

Students are able to

1. ***Know working of conventional sources of electrical energy.***
2. ***Understand behavior of different generating stations.***
3. ***Comprehend operations of different conventional power stations.***
4. ***Appreciate detail study of power station control problem.***

MAL205: NUMERICAL METHODS & PROBABILITY (3-0-0-Credits-3)

Objectives:

- ***Study of various numerical methods.***
- ***Study of probability theory.***

Syllabus:

Numerical Analysis:

Solutions of Algebraic and Transcendental Equations by Iteration Method, Method of False Position, Newton-Raphson Method and Their Convergence, Solutions of System of Linear Equations by Gauss Elimination Method, Gauss Seidal Method, LU Decomposition Method Newton-Raphson Method for System of Nonlinear Equations, Eigen Values and Eigen Vectors: Power and Jacobi Methods.

Numerical Solution of Ordinary Differential Equations:
Taylor's Series Method, Euler's Modified Method, Runge-Kutta Method, Adam's Bashforth and Adam's Moulton, Milne's Predictor Corrector Method. Boundary Value Problems: Shooting Method, Finite Difference Methods.

Probability Theory:
Random Variables, Discrete and Continuous Random Variable, Probability Density Function; Probability Distribution Function for Discrete and Continuous Random Variable Joint Distributions

Definition of Mathematical Expectation, Functions of Random Variables, The Variance and Standard Deviations, Moment Generating Function other Measures of Central Tendency and Dispersion, Skewness and Kurtosis.

Binomial, Geometric Distribution, Poisson Distribution, Relation between Binomial and Poisson's Distribution, Normal Distribution, Relation Between Binomial and Normal Distribution. Introduction to Stochastic Processes.

Text Books:

1. S. D. Canteand, C.de Boor, "Elementary Numerical Analysis-an algorithmic approach", Third Edition, 1981,McGraw-Hill.
2. Gerald and Wheatley Addison, "Applied Numerical Analysis", Seventh Edition, 2003, Wesley.

Reference Books:

1. K.S. Trivedi, "Probability Statistics with Reliability, Queuing and Computer Science applications", Second Edition, 2012 Prentice Hall of India.
2. M.R. Spiegel, "Theory and problems of Probability and statistics", Second Edition, 2008, McGraw Hill Book Company.

Course Outcomes:

Students are able to

1. ***Solve problems based on all types of numerical methods.***
2. ***Study and applications of probability theory.***
3. ***Understand basics of probability distribution function.***
4. ***Know stochastic processes.***

EEP208: Programming Techniques & Simulation LAB (0-0-2-Credits-1)

List of Experiments:

1. Write a program to plot frequency response of LP/HP filters.
2. Write a program for study of maximum power transfer theorem.
3. Write iterative and recursive functions to generate Fibonacci sequence/to find factorial of a number etc.
4. Write a program to plot the transient response of the given RC and RL circuits using analytical solution.
5. Write a program to plot the transient response of the given RC and RL circuits using function in symbolic math tool box.
6. Write a program to compute standard deviation and RMS values of the signal using file I/O.
7. Write a program to extract the fundamental component of a signal using full cycle window DFT.
8. Write program to implement sorting methods: exchange sort, insertion sort, selection sort.
9. Write program to implement searching methods: sequential search, binary search.
10. Write a program to create student database using array of structures and perform functions such as searching and sorting.
11. Write a program to create a bank customer database using cell and perform functions such as searching and sorting.
12. Design the GUI for impedance calculator for series/ parallel RLC circuit.
13. Create a model in Simulink to simulate faults on simple transmission system.

Text Books:

1. Rudra Pratap, "Getting Started with MATLAB 7", Oxford University Press (Indian Edition) 2006.

2. O. Beucher and M. Weeks, "Introduction to MATLAB and Simulink: A Project Approach", Second Edition, 2007, Jones & Bartlett Publishers

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EEP230: Electrical Workshop LAB (0-0-2-Credits-1)

List of Experiments:

1 To study different Electrical Symbols.

2 To study characteristics of fuse wire.

3 To design single phase 50 Hz 230/12 V , 50 VA transformer.

4 To study power Quality interference caused by CFL.

5 Study of switching transients in power system.

6 Study of phase shift of star delta transformer.

7 Study of impact of balanced non linear load on neutral current.

8 Industrial Visit Report.

9 Study different electrical switchgear in substations.

10 Design to hardware mini project.

FIFTH SEMESTER

EEL302: ELECTRICAL MACHINES-II (3-0-0- Credits -3)

Objectives:

- ***This subject imparts knowledge on construction, operation and applications of synchronous and induction motors.***

Syllabus:

Three Phase Induction Motor: Torque Slip Characteristics, Determination of Equivalent Circuit Parameters, Losses and Efficiency, Circle Diagram, Starting, Speed Control and Breaking, High Torque Motors (Double Cage Motor), Crawling and Cogging, Applications, Induction Generator.

Three Phase Synchronous Generator: Introductions, Constructional Features of Cylindrical and Salient Pole Rotor Machines, Steady State Operation of Three Phase Synchronous Generators: Phasor Diagram, Regulation. Steady State Performance of Three Phase Synchronous Generator

Synchronizing of Generator with another Generator: Parallel Operation, Reactances (Parameters) and their Measurement (Experimental Determination), Short Circuit Ratio, Losses and Efficiency
Synchronous Machines on Infinite Bus: Phasor Diagram, Expression for Torque, Load/Torque Angle, Synchronous Motor Operation, Effects of Variable Excitation and Power Input on Generator Operation and Effect of Variable Excitation and Load on Motor Operation.

Transient Behavior: Sudden 3-Phase Short Circuit, Time Constants and Equivalent Circuit Diagrams, Damper Windings.

Introduction To Special Machines: Repulsion Motors, AC Series Motors, Universal Motors, Reluctance Motor, Hysteresis Motor, Schrage Motor, Power Selsyns, Position Selsyns, BLDC motor (Only Elementary Aspects of The above Types Are Expected).

Text Books:

1. P.S. Bhimbra, "Electrical Machinery", Seventh Edition, 1995, Khanna Publishers.
2. I.J. Nagrath, D. P. Kothari, , "Electric Machines", Third Edition, Tata McGraw-Hill Publishing Company Ltd.

Reference Book:

1. E Fitzgerald, Charles Kingsley, Jr. Stephen D. Umans, "Electric Machinery", Tata McGraw-Hill, Fifth Edition.
2. P. K. Mukharjee, S. Chakravarti, "Electric Machines", Dhanpat Rai & Sons.
3. P.S. Bhimbra, "Generalized Theory in Electrical Machines", Khanna Publishers

Course Outcomes:

Students are able to

1. ***Handle the induction machines for various purposes.***
2. ***Look after and interpret the behavior of three phase synchronous machine under different conditions.***
3. ***Appreciate working of special electrical machines***

EEP302: ELECTRICAL MACHINES-II LAB (0-0-2- Credits-1)

List of experiments:

1. To Study the Variation of Speed and Load Test on Schrage Motor.
2. To Plot *V* and Inverted *V (Λ)* Curves of a Synchronous Motor.
3. To determine the ratio X_q/X_d for Three Phase Alternator by using "Slip Test"
4. To Study the Synchronization of an Alternator with an Infinite Bus by "Dark Lamp Method"
5. To determine Potier Reactance of Three Phase Alternator by "Zero Power Factor Saturation Curve".
6. To determine Negative Sequence and Zero sequence Reactances of Synchronous Generator.
7. To Study the Characteristics of Three Phase Induction Generator.
8. To Determine Direct Axis Subtransient (X_d"), Quadrature Axis Subtransient (X_q") Synchronous Reactances of Synchronous Machine.

Reference Book:

1. D. P. Kothari, B. S. Umre, "Laboratory Manual for Electrical Machines", IK International New Delhi.

EEL325: ELECTRICAL POWER SYSTEM-II (3-1-0- Credits-4)

Objectives:

- ***Appreciation of power system concepts like analysis of symmetrical and unsymmetrical faults. Using symmetrical components as a tool for unsymmetrical fault analysis***
- ***Study of stability and economic operation of power system.***

Syllabus:

Symmetrical Fault Analysis Without & With Pre-Fault Load Currents. Symmetrical Component Transformation Three Phase Power in Unbalanced Circuit In Terms Of Symmetrical Component Sequence Impedance of Generator Transformer Transmission Line & Passive Loads Phase Shift In Y/Delta Three Phase Transformer (Yd1, Yd11 Connection). Unsymmetrical Fault Analysis: L-G, L-L-G-, L-L-L, L-L-L-G, Open Conductors Fault Using Symmetrical Components.

Selection of Circuit Breakers Ratings, Current Limiting Reactors.

Stability of Power System – Steady State Dynamic and Transient Stability Definition and Comparison Dynamics of Synchronous Machine Swing Equation Swing Equation for Single Machine Connected To Infinite Bus, Power Angle Equation. Steady State Stability Studies

Transient Stability Studies: Swing Curve, Equal Area Criterion for Transient Stability Application of Equal Area Criterion for Different Disturbances. Solution of Swing Equation by Point by Point Method, Methods of Improving Transient Stability

Economic Operation of Power System: Introduction, Distribution of Load between Units within the Plant. Optimum Generation Scheduling, Considering, Transmission Losses Representation of Transmission Loss Using Loss Formula Co-Efficient Derivation of Loss Formula Co-Efficient Simulation of Co-Ordination Equation on Digital Computer

Grounding Of Neutral in Power System Shunt & Series Compensation Generalized Equation, Shunt Reactor Compensation of Very Long Line with Intermediate Switching Station. Series Capacitor Compensation at Line Centre Shunt Reactor at both Ends and Series Capacitor in Middle of Line Elementary Idea of Sub-Synchronous Resonance Problem and Counter Measures

Text Books:

1. W.D. Stevenson Jr., Elements of power system analysis, McGraw-Hill publications, 3rd Edition
2. I. J. Nagrath, D. P. Kothari, Power System Engineering, Tata McGraw-Hill publications,2008

Reference Books:

1. John J Grainger , W.D. Stevenson , Power System Analysis, McGraw-Hill (India) Pub. , 2003
2. Prabha Kundur, Power System Analysis and Control , TMH, 2008
3. O. I. Elgerd, Electric Energy Systems Theory, McGraw-Hill publications 1971
4. Hadi Saadat, Power System Analysis , TMH , 2002

Course Outcomes

Students are able to

1. ***Apply symmetrical components concepts in fault analysis.***
2. ***Analyze different faults in power system.***
3. ***Appreciate concepts of transient stability.***
4. ***Understand economic operation of power system.***

EEL326: INDUSTRIAL AUTOMATION (3-0-0-Credits -3)

Objectives:

- ***To learn about automation systems in industries***
- ***To learn various ways to program PLC***
- ***To study PLC applications***
- ***To study SCADA system and its applications in power system***

Syllabus:

Introduction to Industrial Automation and Control: Definitions of Automation and Control, Relation between Automation and Information Technology, Role of Automation in Industry, Functional elements of Industrial Automation Systems that perform a variety of functions related to Instrumentation, Control, Supervision and Operations Management, Automation using PLC and SCADA.

Introduction to PLC: Definitions& History of PLC, PLC systems, I/O modules, CPU, Memory, Power supplies, Programmer, Advantages &limitations, Selection criteria for PLC.

Programming of PLC:IEC Programming Standard, Ladder Diagram, Function Block Diagram, Instruction List and Structured Text, Construction of PLC ladder diagram, Basic components & their symbols in ladder diagram, Fundamentals of ladder diagram, Boolean logic & relay logic, Analysis of rungs, Input ON/OFF switching devices, Input analog devices, Output ON/OFF devices, Output analog devices.

Advanced PLC Function: Analog PLC operation, PID control of continuous processes, simple closed loop systems, problems with simple closed loop systems, closed loop system using PID controller, PLC interface, and Industrial process example .Motors Controls: AC Motor starter, AC motor overload protection, DC motor controller, Variable speed (Variable Frequency) AC motor Drive.

Introduction to robotics: Difference between industrial and mobile robots, holonomic and non-holonomic drives for the robot, Types of robots (based on joint link configuration),
Robot architecture: robot joints, configuration space, manipulability of the robot, drives for industrial robots, Industrial applications: welding, spray painting, assembly, material handling.

Control of robot: Linear control schemes: Partitioned proportional derivative controller, partitioned proportional derivative and integral controller, control architecture for hybrid position/ force control scheme, Impedance torque control scheme

Text Books:

1. Gary Dunning, Cengage, "Introduction to Programmable Logic Controllers", Third Edition, 2006, Learning Pub.
2. Frank D. Petruzella, "Programmable Logic Controllers", 2005, Tata McGraw Hill Pub.

Reference Books:

1. W. Bolton, "Programmable Logic Controllers", Fifth Edition, 2009, Newnes Pub.
2. A. James Rehg, Glenn J. Sartori, "Programmable Logic Controllers", 2007, Prentice Hall.
3. Stuart A Boyer, "SCADA supervisory control and data acquisition", 2010, International Society of Automation.
4. R. Mehra, V. Vij, "PLCs & SCADA - Theory and Practice", Laxmi Pub.

Course Outcomes:

Students are able to

1. ***develop awareness of various automation systems in industries.***
2. ***understand the purpose, functions, and operations of a PLC and SCADA***
3. ***able to write programs for PLC.***
4. ***understand working of robot and various control schemes.***

EEP326: INDUSTRIAL AUTOMATION Lab (0-0-2-Credits-1)

List of Experiments:

1. Interfacing of simple I/O devices with PLC for ON & OFF operation
2. DOL starter operation using PLC.
3. Star delta starter operation using PLC.
4. Direction/speed control of a DC motor using PLC
5. Control a conveyer belt using PLC
6. Control a simulated elevator using PLC
7. PLC based thermal ON/OFF control.
8. Interfacing PLC with SCADA, Parameter reading of PLC using SCADA
9. Reporting & trending in SCADA system
10. Project based on PLC

EEL305: CONTROL SYSTEM S -I (3-1-0-Credits -4)

Objectives:

- ***The lessons in basics of control systems will familiarize with the mathematical frame work of the system modeling and analysis.***
- ***Introduction to various techniques used in analysis of the dynamical system.***

Syllabus:

Introduction: Introduction to automation and automatic control, Broad spectrum of the control system applications. Block-diagram and signal-flow-graph algebra.

Mathematical modeling of dynamical systems: Differential equations, Transfer functions. Input-output description of Electrical, electromechanical and other control system components. Servomechanisms and regulators. Loading effect. Concept of feedback and its effect on system parameter variation and disturbances acting on the system.

Time response analysis: Standard inputs used for analysis. First order and second order system time response. Concept of system type and time constants. Time response characteristics. Correlation of the root location to the time response. Dominant poles and approximate time response for higher order system.

Stability analysis: Characteristic equation of a system. Condition for stability. Routh-Hurwitz criterion, special cases for determining relative stability.

Root-locus technique: Relation between open-loop and close-loop system characteristic equations. Need and basic idea of root-locus technique. Construction of root-locus. Assessing close-loop system stability from root-locus.Effect of adding poles and zeros on the root-locus of a system.

Frequency response analysis: Concept of frequency response of a dynamical system. Construction of Bode plot and polar plot for a system. Conformal mapping, Nyquist contour and construction of Nyquist plot for a system. Nyquist stability criterion and stability margins. Reading the stability margin on Bode plot and assessing close-loop stability. Effect of gain variation and addition of poles and zeros on the frequency response plots.

State space technique: Concept of system state and state variable. Writing system math model in state variable form. Derivation of transfer function from state variable model. Introduction to concept of controllability and observability.

Text Books:

1. Benjamin C Kuo, “Automatic Control Systems”, Prentice Hall of India.
2. M. Gopal, “Control Systems- Principle of Design”, Fourth Edition, 2012, McGraw Hill.
3. I.J. Nagrath, “Control Systems Engineering” ,New Age International Ltd. , 2000

Reference Books:

1. D’AzzoHoupis, Logakusha, Huelsoman, “Linear System Analysis”, McGraw Hill.
2. Richard C. Dorf and Robert H. Bishop, “Modern Control Systems”, Pearson Education Inc.
3. Norman S Nise, “Control System Engineering ”, John Wiley & Sons.
4. Katsuhiko Ogata, “Modern Control Engineering”, Prentice Hall of India

Course Outcome:
Student will be able to :

1) ***do mathematical modelling and derivation of transfer function of various systems***
2) ***determine the stability of system and analyse the system in time domain.***
3) ***analyse the systems in frequency domain***
4) ***do state space modelling of system and its analysis.***

EEP305: CONTROL SYSTEMS –I LAB (0-0-2-Credits-1)

List of experiments:

1. To Study the characteristics of Potentiometer as an error detector.
2. To Study the characteristics of a
    i. Synchro transmitter
    ii. Synchro as an error detector
3. To Study transient response of second order R-L-C Circuit using discrete components.
4. To study the Torque-Speed characteristics of Two Phase A.C Servo motor .
5. To Study the effect of addition of pole to the second order closed loop control system by using MATLAB.
6. To Study the frequency response of a second order R-L-C series circuit using discrete components.
7. To Study the phase lead and phase lag networks Using discrete components.
8. To study the effect of addition of pole on frequency response of second order closed loop system by using MATLAB
9. To study the effect of Zero and pole to open loop transfer function of a second order system with unity feed back by using MATLAB.
10. To study the effect of PID controller using a Kit.

EEL307: ELECTRICAL MACHINE DESIGN (3-0-0-Credits-3)

Objectives:

- ***To teach the design principles of magnetic circuit and winding, three phase transformers and 3 phase induction motor.***
- ***Study of heating and cooling of machines.***

Syllabus:

Review of material used in construction of electrical machines. Classification of insulating materials depending upon permissible temperature rise, properties of transformer oil, standard specifications, c.m.r. and short time rating of machine. Heating and cooling characteristics.

Transformer design**:** specific loading, equation for voltage per turn for power and distribution transformer output equation.

Principle of electric and magnetic circuit, design, method of cooling and cooling circuit, design estimation of performance characteristics from the design data.

Induction motor**:** main dimensions, output equation, loading constants, estimation of axial lengths, air gap diameter, winding design. Air gap length, slot dimension for stator and rotor, cage rotor and wound rotor design, calculation of no load current and other performance on characteristics for design data.

Synchronous machine**:** air gap length, method of obtaining sinusoidal output voltage, field coil design for salient pole machine and turbo generator rotor. Ventilation of synchronous generator, cooling air circuits, closed ventilation, quantity of cooling medium- hydrogen and water as cooling media.

Text Books:

1. M. G. Say, "Performance and design of A.C. Machines", Third Edition,2002,CBS Publisher.
2. A. K. Sawhney, "Electrical Machine Design", 2013, Dhanpat Rai and sons.

Reference Books:

1. M.V. Deshpande, "Electrical Machine Design" Third Edition, 2009,PHI Learning Pvt Ltd.
2. J Pyrhonen,T. Jokinen and V.Hrabovcova, " Design of Rotating Electrical Machines" , Wiley,2009.

Course Outcomes:-

Students are able to :-

1. ***Understand EE material properties and concept of specific loading and heating cooling of machines***
2. ***Design Distribution and power transformer.***
3. ***Design Three phase induction motor and synchronous machine***
4. ***Compute the performance of machine from design data***

EEL327: ELECTRIC POWER DISTRIBUTION SYSTEM (3-0-0- Credits -3)

Objectives:

- ***Learning about power distribution system.***
- ***To understand practical aspects of condition monitoring and maintenance of various electrical equipments***

Syllabus:

Design of Electrical Installation: Basic concepts, necessity, design criteria for different electrical equipments, General rules of electrical installation design, Electricity rules, Energy conservation act, Connection to the MV utility distribution network, Connection to the LV utility distribution network.

MV and LV architecture selection guide for buildings, LV distribution, Protection against electric shocks and electric fires, Sizing and protection of conductors, LV switchgear: functions and selection, Overvoltage protection Energy efficiency in electrical distribution, Energy conservation and audit, Power factor correction, Characteristics of particular sources and loads, Residential and other special locations,

Commissioning of electrical equipments**:** Transformer, alternator, circuit breaker, reactor, capacitor bank, CT, CVT, PT, Isolators, control and power cables and governing standards.

Monitoring of electrical installations**:** Off line and on line methods. Fault diagnosis and diagnostic testing. Preventive and predictive maintenance. Special tests. Automated Distribution Systems.
Design of 11 kV substation and its lay out. Protection and maintenance.

Text Books:

1. Pabla A.S., Electric Power Distribution, Tata McGraw Hill Publishing Co. Ltd., Fourth Edition
2. S. Rao, Testing Commissioning Operation and Maintenance of Electrical Equipment, Khanna publishers.

Reference Books:

1. Anthony J Panseni, "Electrical Distribution Engineering", CRC Press
2. James Momoh, "Electric Power Distribution, automation, protection & control", CRC Press
3. S.L.Uppal, "Electrical Power", Khanna Publishers Delhi.
4. Hand book of condition monitoring by B.K.N.Rao, Elsevier Advance Tech., Oxford (UK).

Course Outcomes:
Students will be able to:-

1. ***Design electrical installation pertaining to distribution network***
2. ***Understand protection in LT network.***
3. ***Appreciate commissioning and maintenance aspects of electrical components.***
4. ***Know about IE rules/regulation and energy audit/conservation***

EEL328: OPTIMIZATION TECHNIQUES (3-0-0-credits 3)

Objectives:

- ***To study classical and advanced techniques in optimization.***
- ***To apply knowledge of optimization theory to Electrical Engineering area.***

Introduction – Historical Development, Engineering applications of optimization, statement of an optimization problem, Formulation of optimization problem, classification of optimization techniques. Classical optimization techniques - single variable optimization and multivariable optimization with and without constraints.

Linear programming –Graphical method, Simplex method, Revised simplex method, Duality in linear programming, Dual simplex method, Sensitivity analysis, Application for solving relay coordination problem.

Non linear programming – Unimodal function, One dimensional minimization – unrestricted search, Fibonancci search method and Golden section method, Unconstrained optimization - direct search method (simplex method), Descent methods (steepest descent method and conjugate gradient method), Constrained optimization – sequential quadratic programming method.

Dynamic programming – Multistage decision processes, concept of suboptimization and principle of optimality, linear programming as a case of dynamic programming, Application for solving unit commitment problem.

Evolutionary algorithms for optimization and search; Applications in Electrical Engineering.

Text Books:

1. Engineering Optimization : Theory and Practice, S.S.Rao, New Age International Pub.2011.
2. Operations Research, H.A.Taha, Prentice Hall India Pub., 2007.

Reference Books:

1. Introduction Operations Research, Fredrick S.Hiller Gerald J.L. Lieberman Tata McGraw Hill Pub., 2004.
2. Operations Research – Theory and Applications, J. K. Sharma, Macmillan India Pub., 2009.
3. K. Deb, "Optimization for Engineering Design – Algorithms and Examples", Prentice-Hall of India Pub., 1995.

***Course Outcomes*:**

Students will be able to:

1) ***Formulate optimization problems as mathematical programming problems.***
2) ***Choose suitable technique to solve a particular type of optimization problem.***
3) ***Apply classical optimization techniques to solve linear and nonlinear optimization problems.***
4) ***Apply Evolutionary algorithms to find global optimum of linear and nonlinear optimization problems.***
5) ***Apply various optimization techniques to solve the problems in the area of Electrical Engineering.***

SIXTH SEMESTER

EEL304: ELECTRIC DRIVES & THEIR CONTROL (3-1-0- Credits-4)

Objectives:

- ***Understanding the operation of various drives.***
- ***Learning about selection and control of motors.***

Syllabus:

General structure of electrical drives. Operation and control of Electrical drives.

Rating & Service Capacity: Selection of Motor, Power Capacity For Continuous and Intermittent Periodic Duties, Load Equalization: Flywheel Effect, Speed-Time Relations

AC And DC Contactors And Relays: Magnetic Structure, Operation, Arc Interruption Contactor Rating, H.V. Contactors, Control Circuits For Automatic Starting And Braking Of DC Motor And Three Phase Induction Motor, Control Panel Design

Electrical Traction: Electric Traction system, Speed time curve. Mechanics of Train movement.
Traction motor :Motor Used In AC/DC Traction, Their Performance and Desirable Characteristics, Requirements and Suitability of Motor for Traction Duty. Control of D.C. Traction Motor, Series Parallel Control Starting and Braking of Traction Motor

Brief Idea About Drives Commonly Used in Industries, Digital Control of Electric Motors, Block Diagram Arrangement, Comparison With other Methods of Control. Advanced methods of control of Electrical Drives.

Text Books:

1. G.K Dubey, "Electrical Drives", Second Edition, 2002, PHI.
2. M.L. Soni, P.V. Gupta, U.S.Bhatnagar, "A course in Electrical Power", 1999, Dhanpat Rai & Sons.

Reference Books:

1. Vedam Subrahamanyam, "Electric Drives – Concepts & Applications",1997, Tata McGraw-Hill.
2. H.Partab, "Art & Science of Utilization of Electrical Energy", 1999, Dhanpat Rai & Sons.
3. H.Partab, "Modern Electrical Traction",1973, Pritam Surat & Brothers.

Course Outcomes

Students are able to

1. ***Understand selection of drives for industries.***
2. ***Know operation of contactors and relays.***
3. ***Appreciate selection of drives and their control for traction purposes.***
4. ***Understand the limitation of analogue controller.***

EEL329: SWITCHGEAR AND PROTECTION (3-0-0-Credits- 3)

Objectives:

- ***Comprehensive exposure to philosophy and technology of protection.***
- ***Introduction to switchgear.***

Syllabus:

General philosophy of protective relaying: protective zones. Attributes of relays, Primary protection back up protection, remote and local back up, Medium voltage line protection: over current relaying directional over current relays

High voltage line protection: distance relays, carrier distance schemes. Unit carrier schemes

Equipment protection: principles of differential relaying, protection of generator, transformers and bus bars by differential relaying and other relays. Protection of induction motor's against overload, short-circuits, thermal release, miniature circuit breaker.

Introduction to static relays: comparison of static and electro-mechanical relays, two input amplitude and phase comparators and their duality, generation of various distance relay characteristics using above comparators.

Introduction to numeric protection: Basic principles, filtering, Aliasing, introduction to algorithms.

Switchgear: circuit breakers, arc interruption theory, recovery and re-striking voltages, RRRV, breaking of inductive and capacitive current. Different media of arc interruption, construction and operation of air blast, sf6 and vacuum breakers

Text Books:

1. C.R. Mason –"Art and Science of Protective Relaying", John Wiley & Sons, New York, 1977.
2. Y. G. Paithankar, S.R. Bhide – "Fundamentals of Power System Protection", PHI, 2nd edition, 2010.

Reference Books:

1. S. H. Horowitz, A. G. Phadke –"Power System Relaying", 3rd ed. John Wiley & Sons, 2008.
2. J. L. Blackburn, T. J. Domin – "Protective Relaying, principals and application", 3rd ed. CRC press, 2007.

Course Outcomes:

Students are able to

1. ***Appreciate the philosophy of protective relaying.***
2. ***Apply Over-Current protection for protection of various power system elements.***
3. ***Understand Differential Protection for transformer , bus bar and motor Protection***
4. ***Apply Distance Protection(Carrier and non-carrier) for EHV Lines***
5. ***Comprehend switching phenomenon and the working of various types of circuit breakers and their duties.***

EEP329: SWITCHGEAR AND PROTECTION LAB (0-0-2-Credits-1)

List of experiments:

1. Plotting characteristics of IDMT relay.
2. Finding through fault stability of a simple differential scheme.
3. Plotting characteristics of directional over-current relay.
4. Plotting characteristics of Mho relay on R-X plane.
5. Study of response of percentage biased differential protection scheme for a 3-phase delta/star transformer for various faults like L-G, L-L, L-L-G, L-L-L and inter-turn faults.
6. Plotting characteristics of a simple impedance relay on R-X plane.
7. Plotting characteristics of reactance relay on R-X plane.
8. Simulation of sine and cosine type comparators in MATLAB/Simulink.

Text Books:

1. C.R. Mason, "Art and Science of Protective Relaying", Wiley Eastern, 1977.

Reference Books:

1. English Electric Relay Application Guide.
2. S.H. Horowitz and A.G. Phadke, "Power System Relaying", John Wiley & Sons/RSP , 2008.
3. Y.G. Paithankar, "Transmission Network Protection: Theory and Practice", Marcel Dekker, 1998.
4. Y.G. Paithankar, S.R. Bhide, "Fundamentals of Power System Protection", PHI Learning, 2010.

EEL330: MICROPROCESSOR & MICROCONTROLLERS **(3-0-0-Credits-3)**

Objectives:

- ***To learn architecture and instruction set of microcontroller.***
- ***To learn embedded c programming.***
- ***To study interfacing concepts and applications in area of power system and power electronics.***

Syllabus:

Introduction to microcontrollers: Comparison of Microcontroller with Microprocessor, Criteria for choosing a microcontroller for particular application, Overview of 8051 family.

Introduction to 8051 microcontroller: Review of Architecture, Pin description, Special Function Registers, Addressing Modes, Instruction Set, Assembler directives, illustrative examples, Subroutines, parameter passing to subroutines.
Programming 8051microcontroller using Assembly Language and 'C' Language: I/O port programming, on-chip timer/counter programming, Serial port programming, Interrupt programming,

Interfacing: Interfacing of external memory chips, address allocation technique and decoding; LED, LCD and Keyboard interfacing, Interfacing data converters and sensors, RTC interfacing and programming

Introduction to other microcontroller families like PIC and AVR : Types, Features, Architecture and Programming

Microcontroller Applications: Measurement of Various Electrical and Non-Electrical Parameters, Speed Monitoring and Control of Various Motors, Control of Firing Circuits of Power Electronics Systems, Numerical Protective Relays etc.

Text Books:

1. Kenneth J. Ayala, Dhananjay V. Gadre, Anurag Chugh, "The 8051 Microcontroller and Embedded Systems using Assembly and C", Cengage Learning, Third Reprint, 2011
2. M.A.Mazidi, J.G.Mazidi, R.D.McKinlay, "The 8051 Microcontroller and Embedded Systems using Assembly and C", Pearson Education, Second Edition, 2008

Reference Books:

1. Muhammad Ali Mazidi, Rolin D. McKinlay, Danny Causey,"PIC Microcontroller and Embedded Systems", Pearson Education, 2008
2. David Calcutt, Frederick Cowan, and Hassan Parchizadeh, "8051 Microcontroller: An Applications based Introduction", Newnes Pub., 2004
3. Thomas Schultz, "C and the 8051", 4th Edition, Wood Island Prints, 2008
4. Barry B. Brey, "Applying PIC18 Microcontrollers: Architecture, Programming, and Interfacing Using C and Assembly", Pearson/Prentice Hall, 2008

Course Outcomes:

Students are able to:-

1. ***Understand the architecture of the 8051 microcontroller and PIC16C6X microcontroller.***
2. ***Write assembly language and C language programs for microcontrollers.***
3. ***Interface external peripheral devices with the microcontroller.***
4. ***Understand the microcontroller based applications in electrical engineering.***

EEP330: MICROPROCESSOR & **MICROCONTROLLERS LAB (0-0-2-Credits-1)**

List of Experiments:

1. Write a microcontroller 8051 assembly language program for addition/subtraction of two 16 bit/ 32 bit numbers.
2. Sorting numbers in ascending/descending order using microcontroller 8051 assembly language.
3. Generating a square wave using on chip timer and assembly language of microcontroller 8051.
4. Write a 'C' program to toggle the bits of a port continuously with a delay.
5. Study of microcontroller based phase control using triac.
6. Study of speed control of DC motor using microcontroller.
7. Study of microcontroller based stepper motor speed control.
8. Study of frequency measurement using microcontroller.
9. Other hardware interfacing applications

ECL320: LINEAR ELECTRONIC CIRCUITS (3-0-0-Credits-3)

Objectives:

- ***Study of operational amplifiers.***
- ***Understanding working of linear circuits and linear ICs.***

Syllabus:

Basic Operational Amplifier Circuits: Differential Amplifier Stages, Current Source, Biasing, Level Shifting Techniques, Common Mode and Difference Mode Gains and Impedance of a Differential Stage. Overload Protection Circuits, Frequency Response and Compensation, Characteristics of Ideal and Non-Ideal Operational Amplifier, Error Measurement of Various Parameters

Simple Linear Circuits: Inverting, Non-Inverting Buffer Amplifiers, Summer, Integrator, Differentiator, Log, Antilog, Multipliers, Divider Circuits, Differential Amplifier Configuration, Bridge Amplifiers, Instrumentation Amplifier, Grounding And Shielding Problem in Instrumentation Amplifier

Precision Rectifier, RMS To DC Conversion, Constant Current And Voltage Sources, Sinusoidal Oscillators With Frequency And Amplitude Stabilization, Elementary Idea Of Active Filter With Butterworth 2^{nd} Order Filter Design Procedure

Applications of Operational Amplifier for Clipping Clamping, Comparator Circuits With Nonlinear
Components, Multiplexers, De-multiplexers, Astable Monostable, Bistable Multi-vibrator Circuits Using OA Sample/ Hold Circuits D/A and A/D Conversion Circuits Phase Locked Loops.
Study of Linear ICS like:LM741, LM555, LM565 andLM723

Text Books:

1. R. Gayakwad, "Op-Amps and Linear Integrated Circuits", Fourth Edition ,PHI Pub.
2. R. Coughlin, F. Driscoll, "Operational Amplifiers and Linear Integrated Circuits", PHI Pub.

Reference Books:

1. Tobey, Grames and Huelsman, Operational Amplifiers: Design and Applications, McGraw Hill.

Course Outcomes:

Students are able to

1. ***Understand the basics of operational amplifier.***
2. ***Design linear integrated circuits.***
3. ***Grasp elementary idea of filter design.***
4. ***Know use of different ICs for signal conditioning.***

ECP320: LINEAR ELECTRONIC CIRCUITS LAB (0-0-2-Credits-1)

List of experiments:

1. OP-amp as inverting amplifier.
2. OP-amp as non-inverting amplifier.
3. OP-amp as integrator.
4. OP-amp as differentiator.
5. OP-amp as low pass filter.
6. OP-amp as High pass filter.
7. OP-amp as Schmitt trigger.
8. OP-amp as Comparator.
9. OP-amp as Half wave rectifier.
10. OP-amp as Full wave rectifier.
11. 555 As an Astable multivibrator.
12. 555 As an Monostable multivibrator.

EEL411: Flexible AC Transmission Systems (3-0-0- Credits-3)

Objectives:

- ***To impart the knowledge, to tackle the problem of regulatory constraints on the expansion of power transmission network by introduction of high power electronic controllers for regulation of power flow and voltages in the AC transmission network***

Syllabus:

Introduction of Semiconductor Devices, Steady State and Dynamic Problems in AC Systems, Power Flow

Flexible AC Transmission Systems (FACTS): Basic Realities & Roles, Types of Facts Controller, Principles of Series and Shunt Compensation

Description of Static VAR Compensators (SVC), Thyristor Controlled Series Compensators (TCSC), Static Phase Shifters (SPS), Static Condenser (STATCON), Static Synchronous Series, Compensator (SSSC) and Unified Power Flow Controller (UPFC), IPFC.

Modeling and Analysis of FACTS Controllers, Control Strategies to Improve System Stability, Power Quality Problems in Distribution Systems.

Harmonics, Harmonics Creating Loads, Modeling, Series and Parallel Resonances, Harmonic Power Flow, Mitigation of Harmonics, Filters, Passive Filters, Active Filters, Shunt, Series, Hybrid Filters.

Text Books:

1. N.G. Hingorani, "Understanding of FACTs", Third Edition,2011,IEE press.
2. T.E. Acha, "Power Electronics Control in Electrical Systems", New NES (Elsevier) Publication, 2006.

Reference Books:

1. G.T. Heydt, "Power Quality", 1991, Stars in a Circle Publications, Indiana.
2. T.J.E. Miller, "Static Reactive Power Compensation", 1982, John Wiley & Sons, New York.
3. Yong Hua Song, "Flexible AC transmission system (FACTS)", Illustrated, 1999, IET.
4. Recent publications on IEEE Journals.

Course Outcomes:
Students are able to :-

1. ***understand and analyze the operation of various FACTS devices.***
2. ***model them for overcoming transmission bottle necks and for improvement of power quality.***
3. ***simulate of different controllers and analyzing the effects they make.***
4. ***take up projects on FACTS controllers using modeling aspects.***

EEP411: Flexible AC Transmission Systems LAB (0-0-2- Credits-1)

List of experiments:

1. Familiarization with PSCAD/EMTDC, power world simulator software.
2. Understanding of Reactive Power and Power Factor Correction in AC Circuits
3. To study the effect of real and reactive powers on bus voltages
4. To study the influence of including a tap-changer and a phase-shifter on power flow and bus voltage
5. Modeling of Thyristor Converters.
6. Modeling of Thyristor Controlled Reactors (TCR).
7. Modeling of Thyristor Controlled Series Capacitors (TCSC) .
8. Modeling of Static Shunt compensator (STATCOM).
9. Modeling of Static Synchronous Series compensator (SSSC).

EEL432 : Computer Methods in Power Systems (3-0-0-Credits -3)

Objectives:
The students will learn

- ***Representation of power systems using Graph Theory***
- ***Power System Network Matrices***
- ***Methods of Load Flow Studies***
- ***Computer simulation of Short Circuit Studies***
- ***Computer simulation of transient stability Studies of multi-machine Power Systems***

Syllabus:

Graph Theory Definitions, formation of Bus Incidence Matrix, YBus formation by Direct and Singular Transformation Methods

Formation of ZBus Matrix using method of addition of branch and link, Sparse Matrix representation methods

Power Flow Studies : Necessity of Power flow studies, derivation of Static Load Flow Equation, Load Flow Solution using Gauss Siedel Method (Without & with PV Buses), Acceleration factor, Newton-Raphson Method in rectangular and polar coordinates, Derivation of Jacobian elements, decoupled and fast decoupled load flow method, comparison of different methods, DC load flow

Short Circuit Analysis : Analysis of balanced and unbalanced shunt faults with and without fault impedance, Open conductor faults, simultaneous faults

Modelling of Power system components for transient stability studies, Simulation of transient stability studies for multimachine power systems

Text Books

1. **A.R. Bergen & Vijay Vittal, "Power System Analysis"**
2. **M.A. Pai, " Computer Techniques in Power System Analysis", TMH**

Ref Books

1. **Hadi Saddat, "Power System Analysis", TMH**
2. **J.D. Glover & M.S. Sarma, "Power System Analysis & Design", Thomson**
3. **Grainger & Stevenson, "Power System Analysis", TMH**
4. **M. Pavella & Murthy, "Transient Stability of Power System :Theory & Practice", Wiley 1994**
5. **K.R. Padiyar, "Power System Dynamics, Stabilty & Control ", Interline Publications**

Course Outcome:
Student will be able to :-

1) ***Represent power system network using graph theory***
2) ***Calculate Bus voltages and line flows using load flow methods***
3) ***Calculate short circuit currents, line currents and bus voltages for unbalanced and balanced shunt and series faults***
4) ***Calculate bus voltage magnitudes & angles and evaluate the stability of multimachine power system***

EEP432: COMPUTER METHODS IN POWER SYSTEM LAB (0-0-2- Credits-1)

List of experiment:

1. Simulation experiments based on following software:-
    a. MATLAB (SIMULINK),
    b. PSPICE,
    c. Alternative Transients Program (ATP),
    d. PSCAD,
    e. Power Word Simulator.

SEVENTH SEMESTER

EEL402: HIGH VOLTAGE ENGINEERING (3-0-0- Credits-3)

Objectives:

- ***Understanding the breakdown phenomenon of insulating materials used in electrical system.***
- ***Various high voltage generation and measuring techniques.***
- ***Electrical Apparatus Quality evaluation through testing methodologies***

Syllabus:

Breakdown Mechanism in Dielectrics: Ionization Process, Townsend's Criterion for B.D.: Breakdown in Electro-Negative Gases. In Non-Uniform Fields Corona Discharges and Introduction of Corona, Post B.D. Phenomenon and Applications, Practical Considerations In Using Gases for Insulation Purpose, Vacuum Insulation: Liquid As Insulators. of Solid Di-Electrics in Practice: B.D. In Composite Dielectrics
Lighting and Switching Over Voltages: Mechanism of Lighting, Types of Strokes, Parameter Characteristics Lighting Strokes, Characteristics Switching Surges: Power Frequency Over Voltages Control of O.V. Due To Switching. Protection of Lines by Ground Wires, Protection by Lighting Arrester, Gap Type and Gapless L.A. Selection of L.A. Ratings, Surge Absorbers

Traveling Waves and insulation Co-Ordination: Traveling Waves on Transmission Lines. Classification of Lines Attenuation and Distortion of Traveling Waves Reflection and Transmission of Waves Behaviors of Rectangular Waves at Transition Points Introduction to Insulation Co-Ordination Associated Terms. Impulse Wave-Form Introduction to BIL Reduced BIL and SIL

Generation of High Voltages and Currents: Generation of High D.C. Voltages by Rectifiers. Voltage Doublers and Multiplier Circuits (Derivations of Not Required), Electrostatic Machines. Generation AC Voltages by Transformers Resonant Transformer Generation of High Frequency AC High Voltages, Generation of Impulse Voltages Standard Impulse Wave Shapes Analysis of Model and Commercial Impulse Generation Circuits Wave Shape Control Marx Circuit Tripping and Control of Impulse Generation. Generation of Switching Surges Generation of Impulse Current. Measurement of High AC and DC Voltages by Micro Ammeter

Measurement of High voltage and currents: Generating Voltmeters Resistance and Potential Divider Series Impedance Voltmeters CVT Magnetic Type Potential Transformers. Electrostatic Voltmeter Peak Reading AC Voltmeters Sphere Measurement of Impulse Voltage by Potential Dividers and Peak Reading Voltmeters Measurement of High AC DC Currents Measurement of High Frequency and Impulse Current by Resistive Shunted (Bifillar Strip Shunt Only).

Non Destructive and High Voltage Testing of Electrical Apparatus: Non-Destructive Testing: Measurement of DC Resistively, Measurement of Di-Electric Constant and Loss-Factor (Low and Power Frequency Only), Schering Bridge for High Charging Circuits. For High Dissipation Factor, For Three Terminal Measurement. Transformer Ratio Arm Bridges, Partial Discharge Measurements by Straight Detectors by Balance Detectors, Calibration of Detectors, Discharge Detection in Power Cables High Voltage Testing, Testing of Insulators and S/S Equipments

Text Books:

1. M.S. Naidu, V. Kamaraju, "High Voltage Engineering", Tata McGraw Hill Publishing India, 1999.
2. C.L. Wadhawa, "High Voltage Engineering", Wiley Eastern Ltd, New Age Ltd, India, 1995.

Reference Books:

1. E. Kuffel, "High Voltage Engineering Fundamentals", Butterworth-Heineman, 2000.

Course Outcomes:
Students are able to

1. ***Understand high voltage breakdown phenomena in insulating materials.***
2. ***Design insulation scheme of electrical machines.***
3. ***Know the generation and measurement of high voltage quantities.***
4. ***Analyze the test procedures as per the standards.***

EEP402: HIGH VOLTAGE ENGINEERING LAB (0-0-2- Credits-1)

List of experiments:

1. To determine the breakdown voltage of different solid insulating materials.
2. Testing of transformer oil for breakdown voltage.
3. Calibration of voltmeter by sphere gap arrangement.
4. To study different types of line insulators.
5. To study and find the string efficiency of a given string of insulators.
6. To determine the flashover voltage of pin type insulators under dry and wet conditions.
7. To study the corona phenomenon in overhead lines.
8. To study Impulse Generator.
9. Study of Schering Bridge for capacitance and tan δ measurement of insulating material.

EED401: PROJECT PHASE I (0-0-2- Credits-2)

Objective : **To inculcate culture of handling all aspects of solution of a practical problem**

To develop ability to work in group with peers

To understand, formulate and analyze the problem resulting into a novel solution

Syllabus:

Initiate the work on the topic in areas of electrical and electronics engineering as proposed by project supervisor in terms of following

2. Literature Survey
3. Problem Definition
4. Preliminary investigation
5. Prepare plan of action based on above
6. Present seminars based on the work done at end of semester.

EEL408: ADVANCED POWER ELECTRONICS (3-0-0- Credits-3)

Objectives:

- ***To impart knowledge of recent and advanced developments in PE area.***
- ***To study the advanced applications of PE converters.***
- ***To introduce the new topologies of PE converters***

Syllabus:

Advances in semiconductor devices
Switch mode converter single phase and three phase:
SM Inverters dc to ac / dc to sinusoidal ac and SM rectifier mode of operation.

Four quadrant operation, harmonic analysis.

Voltage control of inverter, different PWM technique SPWM, 60^0 PWM, third harmonic PWM, Space vector PWM, and their comparison

DC-DC converter : Steady-state analysis of non-isolated and isolated (Flyback and forward converter).

Power conditioner, Uninterruptible Power Supply

Resonant converter, different topologies, ZVS/ ZCS principle.

New converter topologies.

Text Books:

1. N. Mohan, T.M. Undeland, W. P. Robbins, "Power Electronics, Converters, Applications and Design", John Wiley & Sons, 1995.
2. M. H. Rashid, "Power Electronics, Circuit, Devices and Applications", Third Edition, 2000, Prentice-Hall of India.

Reference Books:

1. Lender C. W., "Power Electronics", Third Edition, 1989, McGraw Hill.
2. Joseph Vithayathil, "Power Electronics, Principles and Applications", McGraw Hill.
3. Bin Wu, "High Power converter and AC drives", Wiley –IEEE Press, (2006).

Course Outcomes:-

Students are able to

1. ***Learn high performance rectifier and inverter***
2. ***Design DC-DC converter.***
3. ***Design new control techniques to control converters.***
4. ***Appreciate new converter topologies***

EEL409: HVDC transmission (3-0-0- Credits-3)

Objectives:

- ***To expose the students to the state of the art HVDC technology.***
- ***Methods to carry out modeling and analysis of HVDC system forinter-area power flow regulation***

Syllabus:

Development of HVDC Technology, DC versus AC Transmission, Selection of Converter Configuration.

Rectifier and Inverter Operation, Digital Simulation of Converters, Control of HVDC Converters and Systems, Individual Phase Control, Equidistant Firing Controls, Higher Level Controls.

Characteristics and Non-Characteristics Harmonics Filter Design.

Fault Development and Protection, Interaction between AC-DC Power Systems.

Over Voltages on AC/DC Side, Multi-Terminal HVDC Systems, Control of MTDC Systems.

Modeling Of HVDC Systems, Per Unit System, Representation for Power Flow Solution, and Representation for Stability Studies.

Text Books:

1. J. Arrillaga, "High Voltage Direct Transmission", Peter Peregrinus Ltd. London, 1983.
2. K. R. Padiyar, "HVDC Power Transmission Systems", Wiley Eastern Ltd., 1990.

Reference Books:

1. E. W. Kimbark, "Direct Current Transmission", Vol.I, Wiley Interscience, 1971.
2. Erich Uhlmann, "Power Transmission by Direct Current", B.S. Publications, 2004.

Course outcomes

Students are able to

1. ***Understand, analyze and model the HVDC long distance bulk power transmission systems.***
2. ***Simulate converters using MATLAB SIMULINK.***
3. ***Understand necessity of HVDC under deregulated environment.***
4. ***Know different control methods and protective schemes of HVDC systems***

EEL428: INTRODUCTION TO ELECTRIC VEHICLES (3-0-0-Credits-3)

Objectives:

- ***To introduce the concepts of electrical vehicles and their operation.***
- ***To understand the basic components of the EV and their design.***

History of Electrical Vehicles(EV)- Historical Journey of Hybrid and electrical Vehicles(HEV), Economic and environment impact of electrical vehicle

Dynamics of the electric and hybrid electrical vehicles- motion and dynamic equation for vehicles, Vehicle Power Plant and Transmission Characteristics, Basic Architecture of Hybrid Drive Trains and Analysis of Series Drive Train, Power Flow in HEVs, Torque Coupling and Analysis of Parallel Drive Train, Basic Architecture of Electric Drive Trains.

Power Converters- DC-DC converters for EV and HEV applications, DC-AC converters in EV & HEV.

AC Electrical Machines for hybrid and Electric Vehicles- Induction motors, Permanent Magnet Motors. SRM motors, their control and applications in EV/HEV.

Design of Electrical EV/HEV – Principles, Drive cycles and its detail analysis, sizing of electrical machines.

Energy Storage- Batteries, Mathematical modelling of the lead acid batteries, alternative and novel energy sources, fuel cells. Control System for Electric and Hybrid Electric Vehicles- Energy Management strategies and its general architecture, Rule and optimisation based energy management strategies (EMS), EMS based on deterministic rules, Fuzzy rules, Global optimisation.

Design of Hybrid Electric Vehicles- EMS based on real time optimisation, Case study of design of BEV, Design of Series-parallel HEV drive train.

Text Books:

1. Electric Vehicle Technology Explained, by James Larminie, John Lowry, WIELY USA, 2012.
2. Hybrid Electric Vehicles: Principles and Applications with practical prespective, Chris Mi, M. Abdul Masrur & David Wenzhong Gao, WIELY, 2011

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***Reference Books*:**

1. Electric Cars The Future is Now!: Your Guide to the Cars You Can Buy Now and What the Future Holds, by Arvids Linde, Veloce Publishing,2010.
2. Power Electronics for renewable energy systems, transportation, Industrial Applications. By Abu-Rub, Malinowski and Al-Haddad, WILEY, 2014.
3. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, Second Edition (Power Electronics and Applications Series) by Mehrdad Ehsani (Author), Yimin Gao (Author), Ali Emadi (Author) CRC Press, 2009

Course outcome:

The students will be able to :-

1. ***Understand the operation of electrical vehicles.***
2. ***Design the components of the electrical vehicles.***
3. ***Maintenance of the electrical vehicle***

EEL421: POWER QUALITY (3-0-0- Credits-3)

Objectives:

- ***To study the aspects of power quality problems.***
- ***Study of power quality effect in distribution system.***

Syllabus:

Introduction to Power Quality, PQ Standards, Terms, Definitions

Voltage Sag and Interruptions, Its Sources, Types, Characteristics, Behavior of Different Electric Equipments, Concept of Area of Vulnerability

Voltage Swell And Transient Over voltages, Sources of Over voltages Like Capacitor Switching, Load Switching, Lightening Etc. Problems Due To Over Voltages, Computer Tools For Transient Analysis

Harmonics Distortions, Voltage And Current Harmonics, THD, Sources Of Other Harmonics, Its Ill Effects, Inter-harmonics, Harmonic Filters, Other PQ Problems Like EMI, Noise, Notching , Flicker , DC Offset.

Typical Wiring and Grounding Problem Causing Poor Power Quality, Solutions to Wiring and Grounding Problem

Need of Measuring and Monitoring of PQ Problems, Location of Monitoring Equipments and Frequency

Text Books:

1. Roger C. Dugan, "Electrical power system quality" Second Edition, 2012, McGraw Hill.
2. Alexander Kusko, "Power quality in electrical systems", First Edition, 2009, McGraw Hill.

Reference Books:

1. Ewald Fusch, "Power quality in power system and electrical machines", Academic press.
2. H.J. Math, Understanding power quality problems: voltage sags and interruptions by IEEE press.

Course Outcomes

Students are able to:-

1. ***Understand the different power quality indices.***
2. ***Interpret the ill effects of all power quality problems in distribution system.***
3. ***Solve wiring and grounding problems.***
4. ***Analyze harmonics and filters in distribution system.***

EEL412: DSP APPLICATIONS TO POWER SYSTEM (3-0-0- Credits-3)

Objectives:

- ***To make students aware of need and advantages of DSP techniques.***
- ***Appreciation of state of the art approach to digital solutions***

Syllabus:

Overview of the application of DSP in Power System. Need For Numerical (Digital / Computer Based) Controllers. Basic Structure of DSP Based Systems: Power System & DSP System Interface: Signal Transducers, Signal Conditioning: .Data Conversion System Analysis and Design: (Sampling: Shannon's Sampling Theorem, Phenomenon of Aliasing, Anti-Aliasing Filter Design, Sampling Process, Necessity of Sample & Hold , Choice of Sampling Frequency, A/D & D/A Conversion And Quantization Noise, Techniques Of Reducing Quantization Noise, Over-Sampling ADC, Sigma Delta Modulator).

Introduction to General Purpose Digital Signal Processors**:**

Computer Architecture for Signal Processing, Special Purpose DSP Hardware, DSP Arithmetic, ADC Quantization Noise and Signal Quality, Finite World Length Effects, Correlation & Discrete Transform (DFT , Wavelet, Etc) Techniques for Extraction of Fundamental and Harmonic Components Form the Voltage and Current Waveform Samples. DSP Based Relays; Discrete Time FIR and IIR Filters For Implementations of Numerical Relay Algorithms. Power Electronics System Controllers, Some Simple Schemes

Text Books:

1. A.T. Johns, S.K. Salman, Peter Peregrinus, "Digital protection for Power Systems", IEE–U.K. 1995.
2. A.G. Phadke, J.S. Thorp, "Computer Relaying for Power Systems" , Wiley Research Studies Press (2006).

Reference Books:

1. Emmanuel C., Ifeachor, Barrie W Jervis, "Digital Signal Processing (A Practical Approach)", Pearson Education Asia, Second Edition.
2. Alan V Oppenheim, Ronald W Schafer, "Discrete time signal Processing", Prentice Hall of India (private)
3. Limited, New Delhi, 1994.
4. Vinay K Ingle, John G Proakis, "Digital Signal Processing Using MATLAB", Brooks/Cole Publishing Company.
5. Prabhakar S Naidu, "Modern Digital Signal Processing", Second Edition 2006, Narosa Publishing house New Delhi.

Course Outcomes:

Students are able to:-

1. ***Understand concepts of signal conditioning and sampling.***
2. ***Apply various algorithms for estimation of sinusoidal signals.***
3. ***Use DFT and FFT techniques.***
4. ***Design FIR and IIR filters for digital relays.***

MEL424: INDUSTRIAL ENGINEERING & MANAGEMENT (3-0-0-Credits-3)

Objectives:

- ***To understand various fundamental disciplines of management like personnel management, marketing management, financial management etc.***
- ***To apply this basic knowledge to understand the working of corporate world.***

Syllabus:

Principles of management :Concepts of management, development of scientific management, principles of Fredric Taylor & functions such as planning organizing, staffing, leading motivating, communicating, controlling, decision making, span of control .

Personal management: Meaning, functions of personal management, manpower planning, collective bargaining, wages & salary administration, labor welfare, training, trade unions, industrial factories Act, industrial boilers Act, Trade union act.

Plant management: Plant location, plant layout, types of maintenance such as break down, predictive & preventive maintenance, stores of management, industrial safety, causes & cost of accidents, safety programs, production planning & control, job, batch & process type of production

Marketing management: Definition & selling & modern concept of marketing, market research, new product development, product life cycle product launching, sales promotion, pricing, channels of distribution, advertising, market segmentation, marketing mix.

Material management: Importance of material management, classification, codification, forecasting, necessity of inventory

Financial management: Sources of finance, financing organizations, types of capital, elements of costs & allocation of indirect expenses, cost control, break even analysis, budgets & budgetary control, equipment replacement policy, make or buy analysis, balance sheet, ratio analysis, profit & loss statement.

Text books:

1. Koontz, O Daniall, "Principles of management",
2. Kotler P., Stauton "William Principles of marketing management", Prentice Hall, 1985.

Reference Books

1. S.C. Kuchal, "Financial Management", Chaitanya Publishing House
2. T.R.,. Sharma S.C., "Industrial organization & engineering Economics"; Khanna Pub.

Course Outcomes
Students are able to:-

1. ***Understand basics of management***
2. ***Develop understanding of personnel management***
3. ***Appreciate marketing management***
4. ***Demonstrate understanding of material and financial management***

EIGHTH SEMESTER

EED402: PROJECT PHASE II (0-0-4- Credits-4)

Objective : **To inculcate culture of handling all aspects of solution of a practical problem**

To develop ability to work in group with peers

To understand, formulate and analyze the problem resulting into a novel solution

Syllabus:

Find solution to the problems in areas of electrical and electronics engineering as proposed by faculty members in earlier phase and present seminars and submission of project report based on the work done

EEL416: RENEWABLE ENERGY SYSTEMS (3-0-0- Credits-3)

Objectives:

- ***To learn the principles of generating Heat Energy and Electrical energy from Non-conventional / Renewable Energy Sources.***
- ***To gain understanding of the working of Off-grid and Grid-connected Renewable Energy Generation Schemes.***

Syllabus:

Non-Conventional Sources of Electrical Energy – Solar, Wind, Geo-Thermal, Ocean, Tidal, Wave, MHD and Biomass; Their Scope and Potentialities for Energy Conversion

Solar Energy – Introduction, Physical Principles of Conversion of Solar Radiation into Heat, Solar Energy Collectors, Solar Energy Storage, Solar-Electrical Power Generation and Other Miscellaneous Applications of Solar Energy

Wind Energy – Introduction, Basic Principle of Wind Energy Conversion, Wind Data and Energy Estimation, Site Selection, Basic Component of Wind Energy Conversion System, Wind Turbines and Their Analysis, Wind-Electrical Generation.,Stand-Alone and Grid Connected Wind-Electrical Power System, Various Applications of Wind Energy.
Tidal Energy- Introduction, Basic Principles of Tidal Power, Site Selection, Storage, Single and Double Effect Tidal Schemes, Analysis of Tidal Energy Plant

Ocean Energy- Introduction to Wave Energy Based Power Plants, Advantages and Disadvantages, Analysis of Wave Energy Plant

Distributed Generation

Text Book:

1. G.D. Rai, "Non-conventional Energy Sources", Tenth Reprint, 2002, Khanna Publishers, New Delhi.
2. B. H. Khan, "Non-conventional Energy Resources", T McGraw Hill, 2006.

Reference Books:

1. S.P. Sukhatme, J.K. Nayar, "Solar Energy", Tata McGraw Hill Publishing Co. Ltd., New Delhi 2007.
2. Rao and Parulekar, "Energy Technology", Second reprint, 2002, Khanna Publishers, New Delhi.

Course Outcomes:

Students are able to

1. ***Understand the characteristics of non-conventional energy sources.***
2. ***Know working of off-grid renewable energy generation scheme.***
3. ***Know working of grid-connected renewable energy generation scheme.***
4. ***Grasp basics of distributed generation system.***

EEP416: RENEWABLE ENERGY SYSTEMS (0-0-2- Credits-1)

List of experiments:

1 Single PV module I-V and P-V characteristics with radiation and temperature changing effect.

2 I-V and P-V characteristics with series and parallel combination of modules.

3 Effect of shading and Effect of tilt angle on I-V and P-V characteristics of solar module.

4 Study of Stand-alone system using Combine AC and DC load system with battery.

5 Finding MPP by varying the resistive load by varying the duty cycle of DC-DC converter.

6 Finding P_{max} with different values of perturbation (delta D).

7 Perform the experiment with battery in the circuit.

8 Observe the output voltage waveform of inverter in auto mode.

9 Observe the RMS value and waveform of output voltage with both 180 and 120 degree control.

10 Field Visit to Solar Street Lighting System.

11 Study of Solar PV Grid-Tied system .

12 Study of Wind Energy System .

EEL426: CONDITION MONITORING OF ELECTRICAL COMPONENTS (3-0-0-credits 3)

Objectives:

- ***Necessity and importance of condition monitoring and reliability.***
- ***Idea about conventional and recent techniques.***
- ***Development of algorithms and software packages.***

Basic definitions, terminologies, symbolic representation, Necessity from technical social, financial aspect, types of faults in electrical equipments {Electrical equipments such as transformer, CT/PT and rotating electrical machines, CBs, etc.}.

Conventional methods (Measurement of insulation resistance), Diagnostic Testing: Routine tests, type tests, special tests (offline tests).

Recent methods (offline), Dissolved Gas Analysis (DGA), Dissipation Factor (tan δ), Sweep Frequency Response Analysis (SFRA), Partial Discharge (PD), Time Domain Dielectric Response (TDDR), Frequency Domain Spectroscopy (FDS), Chemical analysis. Image processing techniques.

Recent methods (online), vibration and temperature monitoring, sensor and data acquisition system, Modern algorithms, GA, and signal processing techniques. Application to various equipments such as transformer, induction motor, synchronous generator and motor, DC motor, CT and PT, case studies.

Calculation of Power Equipment Reliability for Condition-based Maintenance Decision-making, Optimum Reliability-Centred Maintenance, Cost Related Reliability Measures for Power System Equipment, Reliability based replacement refurbishment/planning

Text Books:

1. P. Vas, "Parameter estimation, condition monitoring and diagnosis of electrical machines", Clarendon Press Oxford.
2. P. Tavner, Li Ran, J. Penman and H. Sedding, "Condition monitoring of rotating electrical machines", IET press

References Books:

1. Xose M Lo´pez, Ferna´ndez, H Bu¨lent Ertan, J Turowski, "Transformers analysis, design, and measurement", CRC Press.
2. M.J. Heathcote, " The J & P Transformer Book", Newnes Publication.
3. S.V. Kulkarni and S.A. Khaparde, "Transformer Engineering: Design, Technology and Diagnostics", CRC Press.
4. R. Billinton and R. N. Allan, *"* Reliability Evaluation of Power Systems, 2nd ed. New York", NY, USA: Plenum, 1996.

1. Video: Transformer condition evaluation with ABBs Mature Transformer Management Program
2. Induction motor condition monitoring with ABBs, Siemens, General Electricals (source You Tube)

Course Outcomes:

Students should be able to

1. ***Understand the necessity of condition monitoring and reliability.***
2. ***Have knowledge about the conventional and modern methodologies/techniques.***
3. ***Develop basic functional models for condition monitoring system to different kind of power apparatus.***
4. ***Know about application of Condition Monitoring System and determination of life expectancy of that equipment***.
5.

EEL427: RESTRUCTURED POWER SYSTEM (3-0-0-credits 3)

***Objective*:**

- ***Secured and reliable operation of power systems,***
- ***Economic efficiency of restructured power systems***

Introduction to restructuring of power industry: Introduction, Reasons for restructuring / deregulation of power industry, understanding the restructuring process, introduction to issues involved in deregulation, reasons and objectives of deregulation of various power systems across the world.

Fundamentals of Economics: Introduction, consumer behaviour, supplier behaviour, market equilibrium, short-run and long-run costs, various costs of production, relationship between short-run and long-run average costs, perfectly competitive market.

The Philosophy of Market Models: Introduction, market models based on contractual arrangements, comparison of various market models, electricity vis-à-vis other commodities, market architecture.

Transmission Congestion Management: Introduction, classification of congestion management methods, calculation of ATC, non-market methods, market based methods, nodal pricing, inter-zonal intra-zonal congestion management, price area congestion management.

Locational Marginal Prices (LMP) and Financial Transmission Rights (FTR) : Mathematical preliminaries, fundamentals of locational marginal pricing, lossless DCOPF model for LMP calculation, loss compensated DCOPF model for LMP calculation, ACOPF model for LMP calculation, introduction to financial transmission rights, risk hedging functionality of financial transmission rights, simultaneous feasibility test and revenue adequacy, FTR issuance process, treatment of revenue shortfall, secondary trading of FTRs, flow gate rights, FTR and market power, FTR and merchant transmission investment.

Ancillary Service Management: Introduction to ancillary services, types of ancillary services, classification of ancillary services, load-generation balancing related services, voltage control and reactive power support services, black start capability service, how to obtain ancillary services?, co-optimization of energy and reserve services.

Pricing of transmission network usage and loss allocation: Introduction to transmission pricing, principles of transmission pricing, classification of transmission pricing methods, rolled-in transmission pricing methods, marginal transmission pricing paradigm, composite pricing paradigm, merits and de-merits of different paradigms, debated issues in transmission pricing, introduction to loss allocation, classification of loss allocation methods.

Market power and generators bidding: Attributes of a perfectly competitive market, the firm's supply decision under perfect competition, imperfect competition, market power, financial markets associated with electricity markets, introduction to optimal bidding by a generator company, optimal bidding methods.

US and European market evolution

Reforms in Indian power sector: Introduction, framework of indian power sector, reform initiatives during 1990-1995, the availability based tariff (ABT), The Electricity Act 2003, open access issues, power exchange, reforms in near future.

Text Books:

1. S. A. Khaparde, A. R. Abhyankar, "Restructured Power Systems" ,Alpha Science International, Limited, 2006
2. Mohammad Shahidehpour, M. Alomoush, "Restructured Electrical Power Systems: Operation: Trading, and Volatility", CRC Press, 2001.

Reference Books:

1. Lorrin Philipson, H. Lee Willis , "Understanding electric utilities and de-regulation", Marcel Dekker Pub., 1998.
2. Steven Stoft , "Power system economics: designing markets for electricity", John Wiley & Sons, 2002.
3. Kankar Bhattacharya, Jaap E. Daalder, Math H.J. Boolen , "Operation of restructured power systems", Kluwer Academic Pub., 2001.
4. www.nptel.ac.in, Restructured Power System (Web course), E-learning courses from IIT and IISC.

Course Outcomes:

Students are able to:-

1. ***bring out the differences between the conventional power system operation and the restructured one.***
2. ***design power markets and market architectural aspects.***
3. ***prepare a background with fundamentals of microeconomics.***

EEL431 : SMART GRID (3-0-0-Credits -3)

Objectives:
The students will be able to :

- ***Understand concept of smart grid and its advantages over conventional grid***
- ***Know smart metering techniques***
- ***Learn wide area measurement techniques***
- ***Appreciate problems associated with integration of distributed generation & its solution through smart grid .***

Syllabus:

Introduction to Smart Grid, Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Concept of Robust & Self Healing Grid, Present development & International policies in Smart Grid.

Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation

Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).

Microgrids and Distributed Energy Resources: Concept of microgrid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuelcells, microturbines, Captive power plants, Integration of renewable energy sources.

Power Quality Management in Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Information and Communication Technology for Smart Grid: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN). Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Basics of CLOUD Computing & Cyber Security for Smart Grid. Broadband over Power line (BPL). IP based protocols.

Text Books:

1. Ali Keyhani, "Design of smart power grid renewable energy systems", Wiley IEEE,2011
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press , 2009
3. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, "Smart Grid: Technology and Applications", Wiley 2012
4. Jean Claude Sabonnadière, Nouredine Hadjsaïd, "Smart Grids", Wiley ISTE 2012

Reference books

1. James Momoh, "Smart Grid Fundamentals of Design and Analysis," Wiley, 2012
2. A. Keyhani, "Smart Power Grid Renewable Energy Systems," Wiley 2011

Course Outcomes:

Student should be able to

1. ***Appreciate the difference between smart grid & conventional grid***
2. ***Apply smart metering concepts to industrial and commercial installations***
3. ***Formulate solutions in the areas of smart substations ,distributed generation and wide area measurements***
4. ***Come up with smart grid solutions using modern communication technologies***

EEL418: CONTROL SYSTEMS - II (3-0-0-Credits-3)

Objectives:

- ***Introduction to the classical control design.***
- ***Introduction to Non-linear control and the digital control.***

Syllabus:

Classical Control Design: System performance specifications, system sensitivity. Proportional, Proportional-Integral, Proportional-Integral-Derivative, lead, lag and lead-lag compensator design using, root-locus and frequency domain techniques. Ziegler-Nichols compensation. Design examples.

Modern Control: Solution of state equation, computation of state transition matrix (STM), properties of STM. Characteristic equation and system stability. Controllability and Observality: Concepts, definitions and Gilbert's and Kalman's tests. Writing the state-space model in phase variable, controllable and observable canonical and diagonal canonical form.Pole-placement by full state feedback.

Non-Linear Control: Common physical non-linearities and their math model. Examples simple pendulum, double pendulum, van der Pol oscillator. Phase-plane method and construction of phase trajectories (a) Direct solution method and (b) Isocline method.Method of harmonic linearisation, describing function its calculation and use. Singular points of non-linear systems and their classification. Stability of non-linear systems: Definitions, local stability, finite and global stability, stability test by Indirect approach and Liapunov's direct method. Introduction to feedback linearisation and sliding mode control.

Digital Control: Basic Elements of discrete data control systems. Data conversion & quantization. Sample and Hold devices. Mathematical modeling of the sampling process. Data reconstruction and filtering of sampled signals: Zero order hold, first order hold. Review of *z*-Transforms, application of *z*-Transforms to difference equations. Pulse transfer function and *z*-Transfer function. Discrete Data System with cascaded elements separated by a sampler and not separated by a sampler. Characteristic equation in discrete domain, correlation between time response and root locations in *s*-plane and *z*-plane. Stability tests of discrete data systems: Bilinear transformation method, extension of RH criterion, Jury's Stability Test.

Text Books:

1. Design of Feedback Control Systems, Stefani, Shahian, Savant, Hostetter, Oxford University Press.
2. Automatic Control Engineering, Francis H. Raven, McGraw Hill, Int.

Reference Books:

2. Control System Theory, Olle I. Elgerd, McGraw Hill, Int.
3. Digital Control of Dynamical Systems, G. F. Franklin, J. D. Powell and M. L. Workman, Pearson Education Asia.
4. *Applied Nonlinear Control*, J. J. E. Slotine and W. Li, Prentice Hall.
5. *Nonlinear Systems*, H. Khalil, Prentice Hall.
6. *Nonlinear Systems: Analysis, Stability, and Control*, S.Sastry, Springer.
7. *Computer Controlled Systems - Theory and Design*,K.J. Astrom, B. Wittenmark, Prentice Hall of India.

Course Outcomes:
Student will be able to;

1. ***design and implement simple controllers for linear systems in continuous time***
2. ***design simple controller in state space representation.***
3. ***analyse the behavior of non-linearities in the system.***
4. ***analyse the behavior of digital systems.***

EEP433 : Computer Applications in Electrical Engineering Lab. (0-0-2 credits- 1)

1) Formation of YBUS using incidence matrix from system data
2) Comparison of receiving end voltage varying line length and using Short, medium and long line models
3) Calculation of Bus voltages using Gauss-Siedel Method
4) Calculation of Jacobian and Bus voltages using NR method
5) Study of power flow using MiPower Software
6) Short-circuit studies using MiPower Software
7) Transient stability simulation for single machine and multi-machine system using Simulink
8) Designing PID controller for second order system