NARAYANA ENGINEERING COLLEGE::GUDUR

AUTONOMOUS

DEPARTMENT OF ELECTRICAL AND ELETRONICS ENGINEERING

Course Structure for B.Tech E.E.E w.e.f AY: 2021-22

SEMESTER I

Course Code	Category	Course Title	Contact Periods per week				Credits	Scheme of Examination Max. Marks		
			L	T	P	Total		Int. Marks	Ext. Marks	Total Marks
21MA1001	BS	Algebra and Calculus	3	1	0	4	4	40	60	100
21PH1001	BS	Applied Physics	3	0	0	3	3	40	60	100
21ES1003	ES	Basic Electrical Circuits	3	0	0	3	3	40	60	100
21ES1001	ES	Problem Solving and Programming	3	0	0	3	3	40	60	100
21PH1501	BS	Applied Physics Lab	**0**	**0**	**3**	**3**	**1.5**	40	60	100
21ES1506	ES	Basic Electrical Circuits Lab	0	0	**2**	**2**	**1**	40	60	100
21ES1505	ES	Engineering and IT Workshop	0	0	**3**	**3**	**1.5**	40	60	100
21ES1501	ES	Problem Solving and Programming Lab	**0**	**0**	**3**	**3**	**1.5**	40	60	100
21EN1502	**HS**	Communication skills lab	**0**	**0**	**2**	**2**	**1**	40	60	100
21MC8001	**MC**	Mandatory course I :Induction Program	Induction Program							
		Counseling/Mentoring	0	0	1	1	0	--	--	--
		Sports/Hobby Clubs/Activities	0	0	2	2	0	--	--	--
		Activity Point Programme	During the Semester					20 Points		
		Total	**12**	**1**	**16**	**29**	**19.5**	**360**	**540**	**900**

SEMESTER II

Course Code	Category	Course Title	Contact Periods per week				Credits	Scheme of Examination Max. Marks		
			L	T	P	Total		Int. Marks	Ext. Marks	Total Marks
21CH1001	BS	Chemistry	3	0	0	3	3	40	60	100
21MA1003	BS	Vector Calculus Complex Variables and Transforms	3	1	0	4	4	40	60	100
21ES1005	ES	Python Programming and Data Science	3	0	0	3	3	40	60	100
21EN1001	HS	English	2	0	0	2	2	40	60	100
21CH1501	BS	Chemistry Lab	0	0	3	3	1.5	40	60	100
21ES1503	ES	Engineering Graphics	0	1	4	5	3	40	60	100
21ES1508	ES	Python Programming and Data Science Lab	0	0	3	3	1.5	40	60	100
21EN1501	HS	English Language Lab	0	0	3	3	1.5	40	60	100
		Counseling/Mentoring	0	0	1	1	0	--	--	--
		Sports/Hobby Clubs/Activities	0	0	2	2	0	--	--	--
		Activity Point Programme	During the Semester					20 Points		
		Total	**11**	**2**	**16**	**29**	**19.5**	**320**	**480**	**800**

SEMESTER III

Course Code	Category	Course Title	Contact Periods per week				Credits	Scheme of Examination Max. Marks		
			L	T	P	Total		Int. Marks	Ext. Marks	Total Marks
21MA1006	BS	Probability Statistics and Numerical Methods	3	0	0	3	3	40	60	100
21ES1009	ES	Data Structures and Algorithms	3	0	0	3	3	40	60	100
21ES1010	ES	Electronic Devices and Circuits	3	0	0	3	3	40	60	100
21PC2001	PC	DC Machines and Transformers	3	0	0	3	3	40	60	100
21PC2002	PC	Electrical Circuit Analysis	2	0	0	2	2	40	60	100
21PC2003	PC	Power System Architecture	3	0	0	3	3	40	60	100
21ES1513	ES	Data Structures and Algorithms Lab	0	0	3	3	1.5	40	60	100
21ES1514	ES	Electronics Devices and Circuits Lab	0	0	2	2	1	40	60	100
21CD6001	SC	Career competency Development I	0	0	2	2	1	40	60	100
21CC6001	SC	Value added course/Certificate course I	0	0	0	0	1	40	60	100
21MC8002-13	MC	Mandatory course II	2	0	0	2	0	--	--	--
		Counseling/Mentoring	0	0	1	1	0	--	--	--
		Sports/Hobby Clubs/Activities	0	0	2	2	0	--	--	--
		Activity Point Programme	During the Semester					20 Points		
		Total	**19**	**0**	**10**	**29**	**21.5**	**400**	**600**	**1000**

SEMESTER IV

Course Code	Category	Course Title	Contact Periods per week				Credits	Scheme of Examination Max. Marks		
			L	T	P	Total		Int. Marks	Ext. Marks	Total Marks
21EN1002	HS	Universal Human Values	3	0	0	3	3	40	60	100
21PC2004	PC	AC Machines	3	0	0	3	3	40	60	100
21PC2005	PC	Analog Electronic Circuits	3	0	0	3	3	40	60	100
21PC2006	PC	Engineering Electromagnetics	3	0	0	3	3	40	60	100
21PC2007	PC	Linear Control Systems	3	0	0	3	3	40	60	100
	OE	Open elective I	3	0	0	3	3	40	60	100
21EE2501	PC	DC Machines and Transformers Lab	0	0	3	3	1.5	40	60	100
21EE2502	PC	Electrical Circuits and Simulation Lab	0	0	3	3	1.5	40	60	100
21EE2503	PC	Linear Control Systems and Simulation Lab	0	0	3	3	1.5	40	60	100
21CD6002	SC	Career competency Development II	0	0	2	2	1	40	60	100
21IC6001	SC	Industry Oriented Course I	0	0	0	0	1	100	--	100
		Counseling/Mentoring	0	0	1	1	0	--	--	--
		Sports/Hobby Clubs/Activities	0	0	2	2	0	--	--	--
		Activity Point Programme	During the Semester					20 Points		
		Total	**18**	**0**	**14**	**32**	**24.5**	**500**	**600**	**1100**

SEMESTER V

Course Code	Category	Course Title	Contact Periods per week				Credits	Scheme of Examination Max. Marks		
			L	T	P	Total		Int. Marks	Ext. Marks	Total Marks
21PC2008	PC	Digital Electronics and logic design	2	0	0	2	2	40	60	100
21PC2009	PC	Power Distribution and Distributed Generation	3	0	0	3	3	40	60	100
21PC2010	PC	Power Electronics	3	0	0	3	3	40	60	100
	OE	Open elective II	3	0	0	3	3	40	60	100
21EE4001-05	PE	Professional Elective I	3	0	0	3	3	40	60	100
21EE2504	PC	AC Machines Lab	0	0	3	3	1.5	40	60	100
21EE2505	PC	Analog Electronics and Simulation Lab	0	0	3	3	1.5	40	60	100
21EE2506	PC	Power Electronics and Simulation Lab	0	0	2	2	1	40	60	100
21CD6003	SC	Career competency Development III	0	0	2	2	1	40	60	100
21CC6002	SC	Value added course/Certificate Course II	0	0	0	0	1	40	60	100
21EE7501	PR	Internship/skill development Training I	0	0	0	0	1.5	00	100	100
21MC8002-13	MC	Mandatory course III	2	0	0	2	0	00	00	00
		Counseling/Mentoring	0	0	1	1	0	--	--	--
		Sports/Hobby Clubs/Activities	0	0	2	2	0	--	--	--
		Activity Point Programme	During the Semester					20 Points		
		Total	**16**	**0**	**13**	**29**	**21.5**	**400**	**700**	**1100**

SEMESTER VI

Course Code	Category	Course Title	Contact Periods per week				Credits	Scheme of Examination Max. Marks		
			L	T	P	Total		Int. Marks	Ext. Marks	Total Marks
21PC2011	PC	Advanced Power System Analysis	3	0	0	3	3	40	60	100
21PC2012	PC	Electrical Measurements and Instrumentation	2	0	0	2	2	40	60	100
21PC2013	PC	Solid State Electric Drives	3	0	0	3	3	40	60	100
21PC2014	PC	Switch Gear and Protection	3	0	0	3	3	40	60	100
	OE	Open Elective III	3	0	0	3	3	40	60	100
21EE4006-10	PE	Professional Elective II	3	0	0	3	3	40	60	100
21EE2507	PC	Electrical Measurements and	0	0	2	2	1	40	60	100
21EE2508	PC	Power Systems Lab	0	0	3	3	1.5	40	60	100
21CD6004	SC	Career competency Development IV	0	0	2	2	1	40	60	100
21IC6002	SC	Industry Oriented Course II	0	0	0	0	1	100	--	100
		Counseling/Mentoring	0	0	1	1	0	--	--	--
		Sports/Hobby Clubs/Activities	0	0	2	2	0	--	--	--
		Activity Point Programme	During the Semester					20 Points		
		Total	**17**	**0**	**10**	**27**	**21.5**	**460**	**540**	**1000**

SEMESTER VII

Course Code	Category	Course Title	Contact Periods per week				Credits	Scheme of Examination Max. Marks		
			L	T	P	Total		Int. Marks	Ext. Marks	Total Marks
21EN5001-8	HS	Humanities and Social Science Elective	2	0	0	2	2	40	60	100
21PC2015	PC	Power System Operation and Control	3	0	0	3	3	40	60	100
	OE	Open Elective IV	3	0	0	3	3	40	60	100
21EE40011-15	PE	Professional elective III	3	0	0	3	3	40	60	100
21EE40016-20	PE	Professional elective IV	3	0	0	3	3	40	60	100
21EE40021-25	PE	Professional elective V	3	0	0	3	3	40	60	100
21EE2509	PC	Electronic systems design lab	0	0	2	2	1	40	60	100
21EE2510	PC	Power Systems Simulation Lab	0	0	3	3	1.5	40	60	100
21CD6005	SC	Career competency Development V	0	0	2	2	1	40	60	100
21CC6501	SC	Skill development Training	0	0	2	2	1	40	60	100
21EE7502	PR	Internship II/on job training/Com Ser Project	0	0	0	0	1.5	00	100	100
21MC8002-13	MC	Mandatory course IV	2	0	0	2	0	--	--	--
		Counseling/Mentorin	0	0	1	1	0	--	--	--
		Sports/Hobby Clubs/Activities	0	0	2	2	0	--	--	--
		Activity Point Programme	During the Semester					20 Points		
		Total	**19**	**0**	**12**	**31**	**23**	**400**	**700**	**1100**

SEMESTER VIII

Course Code	Category	Course Title	Contact Periods per week				Credits	Scheme of Examination Max. Marks		
			L	T	P	Total		Int. Marks	Ext. Marks	Total Marks
21EE7503	**PR**	Project work, seminar and internship	0	0	0	0	12	60	140	200
			0	**0**	**0**	**0**	**12**	**60**	**140**	**200**

OPEN ELECTIVES (OE) Offered by EEE Department

Department	Course Code	Open Elective
Electrical and Electronics Engineering	21EE3001	Artificial Neural Networks and Fuzzy Logic
	21EE3002	Basic Electrical and Electronics Engineering
	21EE3003	Energy Audit and Demand side Management
	21EE3004	Electrical Measurements and Instrumentation
	21EE3005	Utilization of Electrical Energy
	21EE3006	Industrial Automation Engineering
	21EE3007	Industrial Electrical Systems
	21EE3008	Renewable Energy Conversion Systems
	21EE3009	Power Quality

PROFESSIONAL ELECTIVES (PE)

Elective Track/Group	Professional Elective-1	Professional Elective-2	Professional Elective-3	Professional Elective-4	Professional Elective-5
Advanced Power systems	Industrial Electrical Systems (21EE4001)	Power System Planning (21EE4006)	Reactive Power Compensation and Management (21EE4011)	Power Quality (21EE4016)	Smart Grid Technologies (21EE4021)
Control Systems	System Modeling and Identification (21EE4002)	Advanced Control systems (21EE4007)	Digital Signal Processing (21EE4012)	Multivariable Control System (21EE4017)	Real Time Control System (21EE4022)
Electromechanical Systems	Machine Modeling and Analysis (21EE4003)	Electrical Machine Design (21EE4008)	Programmable Control Devices and Applications (21EE4013)	Hybrid Electrical Vehicles (21EE4018)	Automotive Electrical Engineering (21EE4023)
Energy Systems	Renewable Energy Conversion Systems (21EE4004)	Solar and Fuel Cell Energy Systems (21EE4009)	Wind and Biomass Energy Systems (21EE4014)	Utilization of Electrical Energy (21EE4019)	Energy Audit and Demand side Management (21EE4024)
Power Electronics	Advanced Power Electronics (21EE4005)	Advanced Electrical Drives (21EE4010)	HVDC and FACTS (21EE4015)	Advanced Power Converters (21EE4020)	Advanced Power Semiconductor Devices and Protection (21EE4025)

LIST OF HONOR SUBJECTS

S.NO	Course code	Course Name	L-T-P	Credits
1	21EEH001	Adaptive Control Systems	3-1-0	4
2	21EEH002	AC Drives	3-1-0	4
3	21EEH003	Advanced Power System Protection	3-1-0	4
4	21EEH004	Power System Wide area Monitoring and Control	3-1-0	4
5	21EEH005	Restructed Power Systems	3-1-0	4

LIST OF MINOR SUBJECTS

S.NO.	Course code	Course Name	L-T-P	Credits
1	21EEM001	Electrical Technology	3-1-0	4
2	21EEM002	Electrical Measurements and Instrumentation	3-1-0	4
3	21EEM003	Power System Architecture	3-1-0	4
4	21EEM004	Utilization of Electrical Energy	3-1-0	4
5	21EEM005	Linear Control Systems	3-1-0	4

Humanities and Social Science Elective

S. NO	Course code	Course Name	CREDITS
1	21EN1001	Managerial Economics & Financial Analysis	3
2	21EN1002	Management Science	3
3	21EN1003	E-Business	3
4	21EN1004	Organizational Behavior	3
5	21EN1005	Enterprise Resource Planning	3

PROFESSIONAL ELECTIVES (PE)

SEMESTER	Course code	SUBJECT	CREDITS
V Sem	21EE4001-05	Professional Elective I	3
VI Sem	21EE4006-10	Professional Elective II	3
VII Sem	21EE4011-15 21EE4016-20 21EE4021-25	Professional Elective III	3
		Professional Elective IV	3
		Professional Elective V	3
		TOTAL	**15**

OPEN ELECTIVES (OE)

SEMESTER	SUBJECT	CREDITS
IV Sem	Open Elective I	3
V Sem	Open Elective II	3
VI Sem	Open Elective III	3
VII Sem	Open Elective IV	3
	TOTAL	**12**

SKILL ORIENTED COURSE (SC)

SEMESTER	Course code	SUBJECT	CREDITS
III Sem	21CD6001	Career Competency Development I	1
	21CC6001	Value Added Course/Certificate Course I	1
IV Sem	21CD6002	Career Competency Development II	1
	21CC6001	Industry Oriented Course I	1
V Sem	21CD6003	Career Competency Development III	1
	21CC6002	Value Added Course/Certificate Course II	1
VI Sem	21CD6004	Career Competency Development IV	1
	21CC6002	Industry Oriented Course II	1
VII Sem	21CD6005	Career Competency Development V	1
	21CC6501	Skill Development Training	1
		TOTAL	**10**

PROJECT (PR)

SEMESTER	Course code	SUBJECT	CREDITS
V Sem	21EE7501	Internship I/on job training/Com Ser Project	1.5
VII Sem	21EE7502	Internship II/on job training/Com Ser Project	1.5
VIII Sem	21EE7503	Project work, seminar and internship	12
		TOTAL	**15**

HUMANITIES AND SOCIAL SCIENCES (HS)

SEMESTER	Course code	SUBJECT	CREDITS
I	21EN1502	Communication skills lab	1
II	21EN1001	English	2
	21EN1501	English Language Lab	1.5
IV	21EN1002	Universal Human Values	3
VII	21EN5001-8	Humanities and social Science Elective	2
		TOTAL	**9.5**

BASIC SCIENCES (BS)

SEMESTER	Course code	SUBJECT	CREDITS
I	21MA1001	Algebra and Calculus	4
	21PH1001	Applied Physics	3
	21PH1501	Applied Physics Lab	1.5
II	21CH1001	Chemistry	3
	21MA1003	Vector Calculus, Complex Variables and Transforms	4
	21CH1501	Chemistry lab	1.5
III	21MA1006	Probability Statistics and Numerical Methods	3
		TOTAL	**20**

ENGINEERING SCIENCES (ES)

SEMESTER	Course code	SUBJECT	CREDITS
I	21ES1003	Basic Electrical Circuits	3
	21ES1001	Problem Solving and Programming	3
	21ES1506	Basic Electrical Circuits Lab	1
	21ES1505	Engineering and IT Workshop	1.5
	21ES1501	Problem Solving and Programming Lab	1.5
II	21ES1005	Python Programming and Data Science	3
	21ES1503	Engineering Graphics	3
	21ES1508	Python Programming and Data Science Lab	1.5
III	21ES1009	Data Structures and Algorithms	3
	21ES1010	Electronic Devices and Circuits	3
	21ES1513	Data Structures and Algorithms Lab	1.5
	21ES1514	Electronics Devices and Circuits Lab	1
		Total	**26**

PROFESSIONAL CORE (PC)

SEMESTER		SUBJECT	CREDITS
III	21PC2001	DC Machines and Transformers	3
	21PC2002	Electrical Circuit Analysis	2
	21PC2003	Power System Architecture	3
		8	
IV	21PC2004	AC Machines	3
	21PC2005	Analog Electronic Circuits	3
	21PC2006	Engineering Electromagnetics	3
	21PC2007	Linear Control Systems	3
	21EE2501	DC Machines and Transformers Lab	1.5
	21EE2502	Electrical Circuits and Simulation Lab	1.5
	21EE2503	Linear Control Systems and Simulation Lab	1.5
		16.5	
V	21PC2008	Digital Electronics and logic design	2
	21PC2009	Power Distribution and Distributed Generation	3
	21PC2010	Power Electronics	3
	21EE2504	AC Machines Lab	1.5
	21EE2505	Analog Electronics and Simulation Lab	1.5
	21EE2506	Power Electronics and Simulation Lab	1
		12	
VI	21PC2011	Advanced Power System Analysis	3
	21PC2012	Electrical Measurements and Instrumentation	2
	21PC2013	Solid State Electric Drives	3
	21PC2014	Switch Gear and Protection	3
	21EE2507	Electrical Measurements and Instrumentation Lab	1
	21EE2508	Power Systems Lab	1.5
		13.5	
VII	21PC2015	Power System Operation and Control	3
	21EE2509	Electronic systems design lab	1
	21EE2510	Power Systems Simulation Lab	1.5
		5.5	
		TOTAL	**55.5**

EEE Branch Subjects			
R-21			
1.	Electrical Circuit Analysis	III Sem EEE	PC
2.	DC Machines and Transformers	III Sem EEE	PC
3.	Power System Architecture	III Sem EEE	PC
4.	Engineering Electromagnetics	IV Sem EEE	PC
5.	AC Machines	IV Sem EEE	PC
6.	Linear Control Systems	IV Sem EEE	PC
7.	Electrical Circuits and Simulation Lab	III Sem EEE	PC
8.	Linear Control Systems and Simulation Lab	IV Sem EEE	PC
9.	DC Machines and Transformers Lab	IV Sem EEE	PC
Other Branch subjects			
10.	Network Analysis	III Sem ECE	PC
11.	Networks &Control systems Lab	III Sem ECE	PC
12.	Control systems	IV Sem ECE	PC

1. ELECTRICAL CIRCUIT ANALYSIS

MODULE 1 THREE PHASE CIRCUITS 10 hrs

Phase sequence- Star and delta connection-Relation between line and phase voltages and currents inbalanced systems-Analysis of balanced and unbalanced three phase circuits. Two Wattmeter Method of measurement of three phase power, Advantages of Three Phase System.

MODULE 2 DC TRANSIENT ANALYSIS 10 hrs

Transient Response of R-L, R-C, R-L-C Series and Parallel Circuits for D.C Excitation-Initial Conditions-Solution Method Using Differential Equations and Laplace Transforms, Response of R-L &R-C Networks to Pulse Excitation.

MODULE 3 AC TRANSIENT ANALYSIS 8 hrs

Transient Response of R-L, R-C, R-L-C Series and Parallel Circuits for Sinusoidal Excitations-Initial Conditions-Solution Method Using Differential Equations and Laplace Transforms.

MODULE 4 TWO PORT NETWORK 10 hrs

Two Port Network Parameters: Impedance, Admittance, Transmission and Hybrid Parameters and theirRelations, Reciprocity and Symmetry conditions, Concept of Transformed Network, Two Port Network Parameters Using Transformed Variables.

MODULE 5 FILTERS & NETWORK FUNCTIONS 10 hrs

Filters – Low Pass – High Pass and Band Pass – RC, RL filters– derived filters and composite filtersdesign – Attenuators – Network functions for one port and two port networks, pole-zeros of network functions and network stability.

Total 48 hrs

Text Book(s):

1. William Hayt, Jack E. Kemmerly and Jamie Phillips, “Engineering Circuit Analysis”, Mc Graw Hill,9th Edition, 2019.
2. A Sudhakar and Shyam Mohan S Palli, “Circuits and Networks: Analysis and Synthesis”, TMH, 5th Edition, New Delhi, 2015.

Reference Book(s):

1. M.E. Van Valkenberg, “Network Analysis”, 3rd Edition, Prentice Hall (India), 2019.
2. Electric Circuits by N.Sreenivasulu, REEM Publications, 2012
3. Charles K. Alexander and Matthew. N. O. Sadiku, “Fundamentals of Electric Circuits” Mc Graw Hill,2014
4. A. Chakrabarti, “Circuit Theory: Analysis & Synthesis”, Dhanpat Rai & Sons, 2008

2. DC MACHINES AND TRANSFORMERS

MODULE -1 **Electromechanical Energy conversion & DC Generator** **10 hrs**

Principle of Electromechanical Energy Conversion, Energy balance equation, Introduction to DC Generator, principle of operation, Construction details, Armature winding and its types, E.M.F Equation- Numerical problems. Armature Reaction- Cross Magnetizing and De-Magnetizing AT/Pole, Compensating Winding,Commutation.

MODULE -2 **DC Generators &Characteristics** **8 hrs**

Methods of Excitation – Separately Excited and Self Excited Generators, OCC and load characteristics ofdifferent types of generators. Parallel Operation of D.C shunt Generators, Series Generators-Use of Equalizer Bar and Cross Connection of Field Windings – Load Sharing.

MODULE-3 **DC Motor** **10 hrs**

D.C Motor – Principle of Operation, Back Emf, Torque and power developed by armature, Types, Characteristics and Applications of dc Motors, speed control of DC motors, Necessity of starters, Constructional details of 3-point and 4-point starters.

Testing on DC motors: Losses – Constant & Variable Losses, Condition for Maximum Efficiency & Numerical Problems. Methods of Testing - Brake Test, Swinburne's Test, Hopkinson's Test, Field's Test, Retardation Test.

MODULE-4 **Single-Phase Transformers** **10 hrs**

Principle, construction and operation of single-phase transformers, EMF equation, equivalent circuit, phasor diagrams(no load and on load), losses and efficiency, voltage regulation, All Day Efficiency , OC,SC tests & Sumpner's test, separation of hysteresis and eddy current losses. Parallel operation of single-phase transformers.

MODULE-5 **Auto Transformers & Three-Phase Transformer** **10 hrs**

Autotransformers-construction, principle, applications and comparison with two winding transformer. Three- phase transformer – construction, types of connection , Phase conversion - Scott connection, Tap-changingtransformers - No-load and on-load tap changing of transformers.

Total : 48 hrs

Text Book(s):

1. Electrical Machinery, P.S. Bimbhra, Khanna Publishers, 7th Edition, 2011.
2. Electrical Machines, S K Bhattacharya, Mc Graw Hill Education (India) Pvt. Ltd., 4th Edition,2014, 3rd Reprint 2015.

Reference Book(s):

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2014
3. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
4. Electric Machines 4th edition, D.P.Kothari and I.J. Nagrath, Mc Graw Hill Education (India) Pvt.Ltd., 4th Edition, 2010, 16th Reprint 2015.

3. POWER SYSTEM ARCHITECTURE

MODULE – 1 **Non Renewable Generating Stations** **10 hrs**

Thermal Power plant: Importance of electrical power generation-Sources of energy-Conventional and non-conventional sources-Block Diagram of Thermal Power Station (TPS).

Hydro Power plant: Merits and demerits of hydroelectric power plants, Selection of site. General arrangement of hydel plant, Classification of the plants.

Nuclear Power plant: Introduction, Merits and demerits, selection of site, Nuclear reaction, Nuclear fuels, Nuclear plant and layout.

MODULE-2 **Renewable Generating Stations** **10 hrs**

Solar Power Generation: Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Maximizing the Solar PV Output and Load Matching. Maximum Power Point Tracker, Solar PV Systems.

Wind Power Generation: Basic principles of wind energy conversion power in the wind-Forces on blades and thrust on turbines – Wind energy conversion – site selection considerations– types of wind energy collectors.

Bio Energy: Biomass conversion technologies , Bio gas generation , Factors affecting bio digestion or generation of gas , Classification of bio gas plants.

MODULE-3 **Transmission Line Parameters** **10 hrs**

Types of Conductors, Resistance For Solid Conductors – Skin Effect- Calculation of Inductance for Single Phase and Three Phase, Concept of GMR & GMD, Symmetrical and Asymmetrical Conductor Configuration with and without Transposition, Numerical Problems, Capacitance Calculations for Symmetrical and Asymmetrical Single and Three Phase, Effect of Ground on Capacitance.

MODULE-4 **Modeling of Transmission Lines** **8 hrs**

Classification of Transmission Lines and their equivalent circuits- Nominal-T, Nominal-π. Mathematical Solutions to Estimate Regulation and Efficiency. Evaluation of A,B,C,D Constants, Surge Impedance & itsLoading , Wavelengths and Propagation , Ferranti Effect , Charging Current.

MODULE-5 **Performance of Transmission Line** **10 hrs**

Insulators: Types of Insulators, String Efficiency and Methods for Improvement, and numerical problem. **Corona:** Corona Phenomenon, Factors Affecting Corona, Critical and disruptive Voltages and Power Loss, Radio Interference.**Sag and Tension Calculations:** Sag and Tension Calculations with Equal and Unequal Heights of Towers,Effect of Wind and Ice on Weight of Conductor, Stringing Chart, Sag Template .

Total : 48 hrs

Text Book(s):

1. Power System Engineering by M.L.Soni, P.V.Gupta, U.S.Bhatnagar and A.Chakraborti, Dhanpat Rai &Co. Pvt. Ltd., 1999
2. Non Conventional Energy Sources by G.D. Rai, Khanna Publishers, 2000.

Reference Book(s):

1. Principles of power systems by V.K.Mehta,Rohith Mehta S.Chand(P), 4th Edition
2. "Generation of Electrical Energy"- by B.R Gupta-S.Chand Publications,6th Edition(Reprint 2014)
3. Electrical Power Systems for Industrial Plants, Kamalesh Das, JAICO Publishing House, 2008.
4. Electrical power systems, C.L.Wadhwa, New Age International (P) Limited, 6th Edition, 2014

4. ENGINEERING ELECTROMAGNETICS

MODULE – 1 **Electrostatics** **10 hrs**

Vector algebra , Coordinate systems, Vector calculus- Gradient, Divergence and Curl theorems and applications, Sources and effects of electromagnetic fields, Coulomb's Law – Electric field intensity – Fielddue to discrete and continuous charges – Gauss's law and its applications.

MODULE -2 **Electric Field In Materials** **10 hrs**

Electric potential – Electric field and equipotential surface– Electric field in free space, conductors, dielectric -Dielectric polarization – Dielectric strength - Electric fields in multiple dielectrics – Boundary conditions,capacitance, Energy density, Poisson's and Laplace's equations.

MODULE-3 **Electro Magnetics** **10 hrs**

Magnetic field intensity (H) – Biot– Savart's Law - Ampere's Circuit Law – H due to straight conductors, circular loop, infinite sheet of current, Magnetic flux density (B) – Magnetic force, Lorentz force equation,Force on a conductor placed in magnetic field, force between two conductors,- Boundary conditions.

MODULE-4 **Magnetic Potential** **8 hrs**

Scalar and vector magnetic potential, Poisson's Equation, Torque equation, Self Inductance and mutual inductances of solenoid and toroid, Neumann's formula, Energy stored & Energy density.

MODULE-5 **Electrodynamics Fields** **10 hrs**

Magnetic Circuits - Faraday's law – Transformer and motional EMF – Displacement current - Maxwell's equations (differential and integral form) – Time varying potential.

Total : 48 hrs

Text Book(s):

1. Mathew N. O. Sadiku, S.V.Kulkarni, 'Principles of Electromagnetics', 6th Edition, Oxford UniversityPress, 2015, Asian Edition
2. William H. Hayt and John A. Buck, 'Engineering Electromagnetics', Tata McGraw Hill ,8th Revisededition, 2014.

Reference Book(s):

1. Bhag Singh Guru and Huseyin R. Hiziroglu "Electromagnetic field theory fundamentals",CambridgeUniversity Press; Second Revised Edition, 2009.
2. Ashutosh Pramanik, 'Electromagnetism – Theory and Applications', PHI Learning Private Limited,New Delhi, Second Edition-2009
3. Inan U. S. and A. S. Inan, Engineering Electromagnetics, Pearson Education, 2010.
4. Joseph. A.Edminister, 'Schaum's Outline of Electromagnetics, Third Edition (Schaum's OutlineSeries), Tata McGraw Hill, 2010

5. AC MACHINES

MODULE – 1 **Poly Phase Induction Motors** **10 hrs**

Polyphase Induction Motors-Constructional Details of Cage and Wound Rotor Machines, Production of Rotating Magnetic Field, Principle of Operation, Slip, Rotor Power Input, Rotor Copper Loss and MechanicalPower Developed and Their Inter Relationship.

MODULE -2 **Starting Methods of Induction Motors** **10 hrs**

Torque Equation, Expressions for Torque, Torque Slip Characteristics, Load characteristics, Equivalent Circuit, Phasor Diagram, Crawling and Cogging, Circle Diagram.

Starting- Starting methods of squirrel cage and wound rotor induction motor. Speed Control- Various methods of speed control of squirrel cage and wound rotor induction motor.

MODULE-3 **Synchronous Generators** **10 hrs**

Principle and Constructional Features of Salient Pole and Round Rotor Machines , Armature Windings,E.M.F Equation, Armature reaction, Voltage Regulation Methods , Power Flow Equation in Alternators , Synchronizing Power and Torque ,Parallel Operation and Load Sharing , Effect of Change of Excitation and Mechanical Power Input , Determination of Xd and Xq.

MODULE-4 **Synchronous Motors** **8 hrs**

Synchronous Motors Operation – Phasor Diagram – Power Flow Equations in Synchronous Motors- Variation of Current and Power Factor with Excitation – V and Inverted V Curves – Hunting, and Methods to Eliminate Hunting – Starting Methods of Synchronous Motor

MODULE-5 **Single Phase and Special Motors** **10 hrs**

Single Phase Induction Motors ,Constructional Features , Double Revolving Field Theory, Cross Field Theory, Split Phase Motors , Capacitor Start and Run Motors , Shaded Pole Motor, A.C Series Motor - Universal Motor ,BLDC Motors , Reluctance Motor ,Stepper Motor.

Total : 48 hrs

Text Book(s):

1. Electrical Machinery, P.S. Bimbhra, Khanna Publishers, 7th Edition, 2011.
2. Electric Machines 4th edition, D.P.Kothari and I.J. Nagrath, Mc Graw Hill Education (India) Pvt.Ltd., 4th Edition, 2010, 16th Reprint 2015.

Reference Book(s):

1.A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.
3. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
4. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.
5. Electrical Machines, S K Bhattacharya, Mc Graw Hill Education (India) Pvt. Ltd., 4th Edition, 2014,3rd Reprint 2015.

6. LINEAR CONTROL SYSTEMS

MODULE – 1 **Introduction To Control Systems** **10 hrs**

Examples & Classification of control systems, merits and demerits of Open Loop and closed loop control systems, Effects of positive and negative feedback Mathematical modelling and transfer function of Electrical and Mechanical systems, Analogous systems.
Control System Components: DC Servo motor, AC Servo motor , Synchro Transmitter & Receiver
Block diagrams: Block diagram representation of control systems, Block Diagram Reduction Rules .
Signal flow graph: Definitions, Reduction using Mason's gain formula.

MODULE-2 **Time Response Analysis** **10 hrs**

Standard test signals, Time response of first order and second order un damped, under damped, criticallydamped and over damped systems, Time domain specifications.
Error Analysis: Steady state Error**,** static error coefficient of type 0,1, 2 systems.

MODULE-3 **Stability Analysis** **10 hrs**

Stability: The concept of stability, Routh's stability criterion, limitations of Routh's stability.
Root locus plot: The root locus concept, construction of root loci, effects of adding poles and zeros toG(s)H(s) on the root loci.

MODULE-4 **Frequency Response Analysis** **10 hrs**

Introduction, Frequency domain specifications, Bode plot, polar plot, Transfer function from the BodeDiagram, Stability Analysis from Bode Plots. Polar Plots, Nyquist Plots.
Compensation Techniques: Lag, Lead, Lag-Lead Compensators.

MODULE-5 **State Space Analysis** **8 hrs**

Introduction: Concepts of state, state variables and state model, derivation of state models from differential equations, Diagonalization.
Solution of state equation: Solving the Time invariant state Equations, State Transition Matrix and it'sProperties. (2h)The concepts of controllability and observability.

Total : 48 hrs

Text Book(s):

1. "Control Systems Engineering, I. J. Nagrath and M. Gopal, New Age International Publishers,5th edition, 2007, Reprint 2012.
2. Control Systems by A. Anand Kumar, PHI Learning pvt. Ltd., second edition

Reference Book(s):

1. Norman S. Nise, "Control Systems Engineering", John Wiley & Sons PTE Ltd, 2013
2. Modern Control Engineering, Katsuhiko Ogata, PEARSON, 1st Impression 2015.
3. Automatic Control Systems, Farid Golnaraghi and Benjamin. C. Kuo, WILEY, 9th Edition, 2010.
4. N C Jagan, "Control Systems", BS Publications, 1st Edition, 2007.
5. S Palani, "Control Systems Engineering", Tata McGraw-Hill Publications, 1st Edition, 2001.
6. N K Sinha, "Control Systems", New Age International Publishers, 1st Edition, 2002.

7. ELECTRICAL CIRCUITS AND SIMULATION LAB

TASK- 1 - Analysis of three phase circuits

Objective:

To verify phase voltage and line voltage in balanced and unbalanced three phase circuits.

TASK -2 Measurement of Power in three phase Star and Delta Connected loads

Objective:

Measurement of active power of an 3- Φ balanced load using 1- Φ Wattmeter.

TASK-3 Measurement of 3-Phase Power by Two Wattmeter Method for Unbalanced Loads

Objective:

To measure the reactive power consumed by a 3 phase load using 2 wattmeter method.

Task -4 Transient response of RL and RC circuit

Objective:

To verify the **Transient response of RL circuit and to find the time constant of RL and RC network.**

TASK-5 Transient response of series and parallel RLC circuit

Objective:

To verify the Transient response of series and parallel RLC circuit

TASK-6 Low pass & High pass filter

Objective:

To design low pass filter and to plot output verses frequency characteristics

TASK-7 Z & Y parameters

Objective:

To calculate and verify Z -parameters and Y- parameters of given two-port network

TASK-8 Transmission and Hybrid Parameters

Objective:

To calculate and verify 'ABCD' parameters and h- parameters of given two-port network

TASK-9 Simulation of Transient Response of DC and AC circuits

Objective:

To simulate the transient response of simple DC and AC circuits using PSpice

TASK -10 Simulation of k and m- pass filters

Objective:

To simulate the k and m-pass filters using PSpice.

Additional Experiments:

Virtual Labs:

1. Parallel RC Circuits
2. Parallel LC Circuits
3. Series RL Circuits
4. Series LCR Circuit
5. Parallel LCR Circuits

Text Book(s):

1. Simulation of Power Electronics Circuit, M B Patil, V Ramanarayan and V T Ranganat, AlphaScience International Ltd., 2009.

Reference Book(s):

1. A Sudhakar, Shyammohan S Palli, “Circuits & Networks”, Tata McGraw- Hill, 4th Edition, 2010.
2. WillamHayt.jr, Jack E.kemmerly,Steven M.Durbin, “Engineering Circuit analysis” Tata McGraw- Hill,8th Edition2012

8. LINEAR CONTROL SYSTEMS & SIMULATION LAB

Task-1:Time Response of Second Order System

Objective: To study the response of a second order system considering a series RLC circuit.

Task-2: Characteristics of Synchro pair

Objective: To study the characteristics of synchro transmitter-Receiver pair.

Task-3: Characteristics of AC Servo Motor

Objective: To draw the characteristics of ac servo motor and to calculate parameters of motor K1 and K2

Task-4: Characteristics of DC Servo Motor

Objective: :

1.To obtain the Speed Vs voltage characteristics of the DC motor

2.To obtain Speed Vs Torque characteristics and Ia Vs Torque Characteristics

Task-5: Transfer Function of DC Machine

Objective:

1.To determine the Transfer function of a given DC motor.

2.To determine the transfer function of a D.C. generator after determining the various constants.

Task-6: Characteristics of Magnetic Amplifier

Objective: To determine the characteristics of magnetic amplifier in three modes

1) Series connected magnetic amplifier

2) Parallel connected magnetic amplifier

3) Self saturated magnetic amplifier.

Task-7: Lag and Lead Compensation – Magnitude and Phase Plot

Objective: To Plot Magnitude and Phase Plot

Task-8: Effect of P, PD, PI, PID Controller on a Second Order System.

Objective: To study the effect of P, PD, PI, PID controllers on a second order system.

Task-9: Temperature Controller Using PID

Objective: To study the closed loop PID control in a temperature process.

Task-10: Programmable Logic Controller.

Objective: To Study and Verification of Truth Tables of Logic Gates, Simple Boolean Expressions and Application of Speed Control of Motor

Any two simulation experiments are to be conducted:

Task-11: Linear System Analysis Using MATLAB.

Objective: To Determine the Time domain specification and Steady state errors for given linear systems theoretically and practically

Task-12: Stability Analysis (Bode, Root Locus, Nyquist) of Linear Time Invariant System Using MATLAB

Objective: To Plot the Root Locus, bode ,Nyquist) of a given Transfer Function using MATLAB

Text Book(s):

1 . Simulation of Electrical and electronics Circuits using PSPICE - by M.H Rashid, M/S PHI Publications.

2. MATLAB and its Tool Books yser's manual and - Mathworks, USA

3. I. J. Nagrath and M. Gopal, “Control Systems Engineering”5th edition, New AgeInternational (P) Limited Publishers, 2007.

9. DC MACHINES AND TRANSFORMERS LAB

TASK-1 Magnetization characteristics of DC shunt generator. Determination of critical field resistance and critical speed.

Objectives:

a) Predetermine the OCC at different speeds

b) Determine the critical field resistance

c) Obtain maximum voltage built up with given shunt field resistance

d) Obtain critical speed for a given shunt field resistance

TASK -2 Load test on DC shunt generator. Determination of characteristics.

Objectives:

a) Determine the external & internal characteristics

b) Deduce the armature reaction curve

TASK -3 Load test on DC compound generator. Determination of characteristics.

Objectives:

a) Determine the external characteristics cumulative compound condition

b) Determine the external characteristics differential compound condition

TASK -4 Brake test on DC shunt motor. Determination of performance curves.

Objectives: Plot the following characteristics

i) Efficiency Vs Output

ii) Line current Vs Output

iii) Speed Vs Output

iv) Torque Vs Output

v) Line current Vs Torque

TASK -5 Swinburne's test of DC shunts motor. Predetermination of efficiencies.

Objectives:

a) Predetermine the armature current and percentage efficiency when the machine operates as a motor for various load conditions.

b) Predetermine the armature current and percentage efficiency when the machine operates as a generator for various load conditions.

c) plot efficiency Vs output curves.

TASK-6 Brake test on DC compound motor. Determination of performance curves.

Objectives: Plot the following characteristics

i) Efficiency Vs Output

ii) Line current Vs Output

iii) Speed Vs Output

iv) Torque Vs Output

v) Line current Vs Torque

TASK-7 Hopkinson's tests on DC shunt machines. Predetermination of efficiency.

Objectives:

a) Determination of the efficiency of the given dc shunt machine working as a motor Under various load conditions.

b) Determination of the efficiency of the given dc shunt machine working as a Generator under various load conditions.

TASK-8 Fields test on DC series machines. Determination of efficiency.

Objectives:

a) Determination of the efficiency of the given dc series machine working as a motor under various load conditions.

b) Determination of the efficiency of the given dc series machine working as a Generator under various load conditions.

TASK-9 O.C. & S.C. Tests on Single phase Transformer.

Objectives: Predetermination of the following

a) Efficiency at different load conditions and different power factors

b) Regulation at different load conditions and different power factors

c) Equivalent circuit referred to HV and LV sides

d) UPF load at which efficiency is maximum

e) Power factors at which regulation is maximum and zero

f) Regulation vs. power factor curves

TASK -10 Sumpner's Test on a Pair of Single Phase Transformers

Objectives:

a) Predetermination of efficiency at different load conditions and power factors

b) Predetermination of regulation at different load conditions and power factors

Additional Experiments

TASK-13 Load test on single phase transformer

Objectives:

a) Determination of the efficiency at different load conditions and unity power factor

b) Determination of the regulation at different load conditions and unity power factor

c) Plot efficient vs. output & regulation Vs output curves

TASK -14 Parallel Operation of Single Phase Transformers

Objectives:

a) To determine the load sharing of each transformer by their equivalent impedances

b) To verify the load sharing by actual measurements

Text Book(s):

1. Electrical Machinery, P.S. Bimbhra, Khanna Publishers, 7th Edition, 2011.

2. Electrical Machines, S K Bhattacharya, Mc Graw Hill Education (India) Pvt. Ltd., 4th Edition,2014, 3rd Reprint 2015.

Reference Book(s):

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013

2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2014

3. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.

4. Electric Machines 4th edition, D.P.Kothari and I.J. Nagrath, Mc Graw Hill Education (India) Pvt.Ltd., 4th Edition, 2010, 16th Reprint 2015.

10. NETWORK THEORY

MODULE – 1 **Resonance** **10 hrs**

Introduction, Definition of quality factor **Q** of inductor and capacitor, Series resonance, Bandwidth of the series resonant circuits, Parallel resonance (or anti-resonance), Locus diagram for Series R-L, R-C, R-L-C and Parallel Combination with Variation of Parameters.

MODULE -2 **DC Transient Analysis** **10 hrs**

Transient Response of R-L, R-C, R-L-C Series and Parallel Circuits for D.C Excitation-InitialConditions-Solution Method Using Differential Equations and Laplace Transforms, Response of R-L & R-C Networks to Pulse Excitation.

MODULE -3 **AC Transient Analysis** **8 hrs**

Transient Response of R-L, R-C, R-L-C Series and Parallel Circuits for Sinusoidal Excitations-Initial Conditions-Solution Method Using Differential Equations and Laplace Transforms.

MODULE -4 **Two Port Networks** **10 hrs**

Two Port Network Parameters: Impedance, Admittance, Transmission and Hybrid Parameters and theirRelations, Reciprocity and Symmetry conditions, Concept of Transformed Network, Two Port Network Parameters Using Transformed Variables.

MODULE-5 **Filters & Network Functions** **10 hrs**

Filters – Low Pass – High Pass and Band Pass – RC, RL filters– derived filters and composite filters design – Attenuators – Network functions for one port and two port networks, pole-zeros of networkfunctions and network stability

Total : 48 hrs

Text Book(s):

1. A Sudhakar and Shyam Mohan SP, “Circuits and Networks: Analysis and Synthesis”, TMH, 5th Edition, New Delhi, 2015.
2. Ravish R., Network Analysis and Synthesis, 2/e, McGraw-Hill, 2015

Reference Book(s):

1. S.Sivanagaraju, G.Kishor & C.Srinivasa Rao, "Electrical Circuit Analysis", Cengage Learning, 1stEdition, 2010.
2. A. Chakrabarti : Circuit Theory (Analysis and Synthesis), Dhanpat Rai &Co

3. Joseph A. Edminister and Mahmood Nahvi, "Electric Circuits Schaum"s Outline Series", 6th Edition,Tata McGraw-Hill, 2014, New Delhi.

11. NETWORKS & CONTROLSYSTEMS LAB

TASK -1 Transient response of RL and RC circuit
Objective:
To verify the Transient response of RL circuit and to find the time constant of RL and RCnetwork.

TASK -2 Transient response of RLC series circuitObjective:
To verify the Transient response of RLC series circuit

TASK -3 Frequency response of series resonance circuit with analysis and design

Objective:

To determine resonant frequency, band width and Q-factor for series RLC circuits

TASK-4 Locus Diagrams of RL and RC Series CircuitsObjective:
To Plot the current locus diagrams for RL and RC circuits.
TASK-5 Z and Y Parameters
Objective:
To calculate and verify 'Z' parameters and Y parameters of two-port network.
TASK-6 Design and frequency response of constant 'k' low pass & high pass filtersObjective:
To plot the frequency response of Low pass filter and High pass filter
TASK-7 Time Response of Second Order System

Objective:
To verify Time response of second order system.
TASK- 8- Characteristics of Synchro pair

Objective:

To verify characteristics of synchro pair

TASK -9 Characteristics of DC Servo Motor

Objective:

To verify characteristics of DC servo motor

TASK-10 Transfer Function of DC Machine

Objective:

To verify transfer function of DC Machine

Additional Experiments

TASK-11 Simulation of AC Circuits

TASK-12 Linear System Analysis (Time Domain Analysis, Error Analysis) Using MATLAB.

TASK-13 Stability Analysis (Bode, Root Locus, Nyquist) of Linear Time Invariant System Using MATLAB

Text Book(s):

1.A Sudhakar, Shyammohan S Palli, "Circuits & Networks", Tata McGraw- Hill, 4th Edition, 2010

2.A Chakrabarthy, "Electric Circuits", Dhanpat Rai & Sons, 6th Edition, 2010.

Reference Book(s):

1.Simulation of Electrical and electronics Circuits using PSPICE - by M.H Rashid, M/S PHI Publications.

2.PSPICE A/D user's manual --Microsim USA

12. CONTROL SYSTEMS

MODULE-1 **Introduction To Control Systems** **10 hrs**

Examples & Classification of control systems, merits and demerits of Open Loop and closed loop controlsystems, Effects of positive and negative feedback
Mathematical modelling and transfer function of Electrical and Mechanical systems, Analogous systems.**Control System Components**: DC Servo motor, AC Servo motor , Synchro Transmitter & Receiver **Block diagrams**: Block diagram representation of control systems, Block Diagram Reduction Rules)**Signal flow graph**: Definitions, Reduction using Mason's gain formula

MODULE-2 **Time Responce Analysis** **10 hrs**

Standard test signals, Time response of first order and second order un damped, under damped, criticallydamped and over damped systems, Time domain specifications.
Error Analysis: Steady state Error**,** static error coefficient of type 0,1, 2 systems .

MODULE-3 **Stability Analysis** **10 hrs**

Stability: The concept of stability, Routh's stability criterion, limitations of Routh's stability.
Root locus plot: The root locus concept, construction of root loci, effects of adding poles and zerostoG(s)H(s) on the root loci.

MODULE-4 **Frequency Response Analysis** **10 hrs**

Introduction, Frequency domain specifications, Bode plot, polar plot, Transfer function from the BodeDiagram, Stability Analysis from Bode Plots. Polar Plots, Nyquist Plots. .
Compensation Techniques: Lag, Lead, Lag-Lead Compensators.

MODULE-5 **State Space Anlysis** **8 hrs**

Introduction: Concepts of state, state variables and state model, derivation of state models from differential equations, Diagonalization.
Solution of state equation: Solving the Time invariant state Equations, State Transition Matrix andit'sProperties.The concepts of controllability and observability.

Total : 48 hrs

Text Book(s):

1. "Control Systems Engineering, I. J. Nagrath and M. Gopal, New Age InternationalPublishers,5th edition, 2007, Reprint 2012.
2. Control Systems by A. Anand Kumar, PHI Learning pvt. Ltd., second edition

Reference Book(s):

1. Norman S. Nise, "Control Systems Engineering", John Wiley & Sons PTE Ltd, 2013
2. Modern Control Engineering, Katsuhiko Ogata, PEARSON, 1st Impression 2015.
3. Automatic Control Systems, Farid Golnaraghi and Benjamin. C. Kuo, WILEY, 9th Edition, 2010.

4. N C Jagan, “Control Systems”, BS Publications, 1st Edition, 2007.
5. S Palani, “Control Systems Engineering”, Tata McGraw-Hill Publications, 1st Edition, 2001.
6. N K Sinha, “Control Systems”, New Age International Publishers, 1st Edition, 2002.

List of Open Elective Subjects:

Open Elective Subjects			
1.	Artificial Neural Networks and Fuzzy Logic	NA	OE
2.	Basic Electrical and Electronic Engineering	NA	OE
3.	Energy Auditing and Demand Side Management	NA	OE
4.	Electrical Measurements and Instrumentation	NA	OE
5.	Utilization of Electrical Energy	NA	OE
6.	Industrial Automation Engineering	NA	OE
7.	Industrial Electrical Systems	NA	OE
8.	Renewable Energy Conversion Systems	NA	OE
9.	Power Quality	NA	OE

1.ARTIFICIAL NEURAL NETWORKS & FUZZY LOGIC

MODULE – 1 INTRODUCTION TO ARTIFICIAL INTELLIGENCE 10 hrs

Introduction to Artificial intelligence, Approaches to AI, Architectures of AI, Symbolic reasoning system, Rule based systems, Knowledge representation, Expert systems.

MODULE -2 ARTIFICIAL NEURAL NETWORKS 10 hrs

Basics of ANN, Comparison between Artificial and Biological Neural Networks, Basic Building Blocksof ANN, Artificial Neural Network Terminologies, McCulloch Pitts Neuron Model, Learning Rules, ADALINE and MADALINE Models, Perceptron Networks, Back Propagation Neural Networks – Associative Memories.

MODULE-3 ANN APPLICATIONS TO ELECTRICAL SYSTEMS 8 hrs

ANN approach to: Electrical Load Forecasting Problem, System Identification, Control Systems, Pattern Recognition.

MODULE-4 CLASSICAL RELATIONS AND FUZZY RELATIONS 10 hrs

Classical Sets, Fuzzy Sets, Operations on classical sets, Properties of crisp sets, Operations on fuzzy sets, Properties of Fuzzy sets, Fuzzy Relations- Cardinality, Cartesian product, Fuzzy compositions, Fuzzy Equivalence Relation & Fuzzy Tolerance Relation

MODULE-5 FUZZY LOGIC AND APPLICATION 10 hrs

Fuzzification & Defuzzification- Methods, Membership Functions, Fuzzy Rule base, Genetic Algorithm , Fuzzy Logic Controller Design, Features of a simple Fuzzy Logic Control system, NeuroFuzzy Controller. Fuzzy Logic Implementation for Induction Motor Control, Switched Reluctance Motor Control, Fuzzy Excitation Control Systems in Automatic Voltage Regulator, Fuzzy Logic Controller in an 18 Bus Bar System. **Total : 48 hrs**

Text Book(s):

1. S. N. Sivanandam, S. Sumathi and S. N. Deepa, “Introduction to Neural Networks using MATLAB”,McGraw Hill Edition, 2006.
2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, Third Edition,WILEY India Edition,2012.
3. Neural Networks – Simon Hakins , Pearson Education

Reference Book(s):

1. S. N. Sivanandam, S. Sumathi and S. N. Deepa, “Introduction to Fuzzy Logic using MATLAB”, SpringerInternational Edition, 2013.
2. Yung C. Shin and Chengying Xu, “Intelligent System – Modeling, Optimization & Control, CRC Press,200
3. Elaine Rich, Kevin Knight ,Shivashankar B Nair, “ Artificial intelligence” McGraw Hill third Edition

2. BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

MODULE – 1 **DC & AC Circuits** **08 hrs**

Electrical circuit elements (R - L and C) - Kirchhoff laws - Series and parallel connection of resistances with DC excitation. Superposition Theorem - Representation of sinusoidal waveforms - peak and rms values - phasor representation - real power - reactive power – apparent power.

MODULE -2 **DC Machines** **08 hrs**

Principle and operation of DC Generator - EMF equations - principle and operation of DC Motor –Types of DC Motor - Brake Test on DC Shunt Motor - Characteristics of DC Motor - Applications.

MODULE-3 **AC MACHINES** **08 hrs**

Principle and operation of Single Phase Transformer - OC and SC test on transformer - principle and operation of Three Phase Induction Motor - Characteristics and Applications.

PART B:

MODULE-4 **Semicondcutor Diodes** **08 hrs**

PN diode, Diode as Switch, Zener Diode, Tunnel diode, Varactor diode, LED, Photodiode: their characteristics and applications

.

MODULE-5 **Bipolar Junction Transistor** **08 hrs**

Bipolar Junction Transistor (BJT) – Types of Transistors, Operation of NPN and PNP Transistors, Input- Output Characteristics of BJT-CB, CE and CC Configurations, Relation between IC, IB and IE, Transistor Applications- Transistor as an Amplifier, Transistor as a Switch.

MODULE-6 Metal–Oxide–Semiconductor Field-Effect Transistor **08 hrs**

Introduction to MOSFET, Construction of depletion mode and enhancement mode of NMOS and PMOS, Drain characteristics of MOSFET, Transfer Characteristics of MOSFET, MOSFET as Switch, CMOS Inverter and it's Characteristics. **Total : 48 hrs**

Text Book(s):

1.D. P. Kothari and I. J. Nagrath - “Basic Electrical Engineering” - Tata McGraw Hill - 2010.

2.Basic Electrical and Electronics Engineering, M.S.Sukhija, T.K.Nagsarkar, Oxford University.

3.V.K. Mehta &Rohit Mehta, “Principles of Electronics” – S.Chand –2018.

4. Basic Electrical and Electronics Engineering, S.K Bhattacharya, Pearson Education,2012.

Reference Book(s):

1. L. S. Bobrow - “Fundamentals of Electrical Engineering” - Oxford University Press - 2011.

2 J. Millman, C. Halkias, “Electronic Devices and Circuits”, Tata Mc-Graw Hill, 4th Edition,2010.

3.David A.Bell, “Electronic Devices and Circuits”, Fifth Edition, Oxford University Press, 2009.

3.ENERGY AUDITING AND DEMAND SIDE MANAGEMENT

MODULE – 1 INTRODUCTION TO ENERGY AUDITING 10 hrs

Energy Situation – World and India, Energy Consumption, Conservation, Energy audit- definitions, concept, types of audit, energy index, cost index ,pie charts, Sankey diagrams , load profiles, Energy conservation schemes- Energy audit of industries

MODULE -2 ENERGY MANAGEMENT 9 hrs

Principles of energy management, organizing energy management program, initiating, planning , Controlling, promoting, monitoring, reporting. Energy manger, Qualities and functions ,language ,Questionnaire - check list for top management.

MODULE-3 ENERGY EFFICIENT MOTORS AND POWERFACTOR IMPROVEMENT 10 hrs

Energy Efficient Motors , Factors Affecting Efficiency, Loss Distribution , Constructional Details , Characteristics - Variable Speed , Variable Duty Cycle Systems, RMS Hp- Voltage Variation-Voltage Unbalance- Over Motoring- Motor Energy Audit. Power Factor – Methods of Improvement, Power factor With Non Linear Loads.

MODULE-4 LIGHTING AND ENERGY INSTRUMENTS FOR AUDIT 9 hrs

Good Lighting System Design and Practice, Lighting Control, Lighting Energy Audit - Energy Instruments- Watt Meter, Data Loggers, Thermocouples, Pyrometers, Lux Meters, Tong Testers, Application of PLC's.

MODULE-5 CONCEPTS,ECONOMIC ASPECTS AND COSTEFFECTIVENESS TESTS OF DSM PROGRAMS 10 hrs

Concept of DSM, Benefits of DSM, Different Techniques of DSM – Time of Day Pricing, Multi-Utility Power Exchange Model, Time of Day Models for Planning. Load Management, Load Priority Techniques, Peak Clipping, Peak Shifting, Valley Filling, Strategic Conservation, Energy Efficient Equipment. Basic payback calculations, Depreciation, Net present value calculations, Cost effectiveness test for demand side management programs. **Total : 48 hrs**

Text Book(s):

1. Industrial Energy Management Systems**,** Arry C. White, Philip S. Schmidt, David R. Brown, HemispherePublishing Corporation, New York, 1994.
2. Fundamentals of Energy Engineering -Albert Thumann, Prentice Hall Inc, Englewood Cliffs, New Jersey1984.
3. Handbook on Energy Audit and Environment Management ,YPAbbi and Shashank Jain,TERI,2006

Reference Book(s):

1. Energy management by W.R. Murphy & G. Mckay Butter worth, Heinemann publications.
2. Energy management by Paul o" Callaghan, Mc-graw Hill Book company-1/e,1998
3. Energy efficient electric motors by John C. Andreas, Marcel Dekker Inc Ltd-2/e, 1995
4. Energy management hand book by W.C.Turner, john Wiley and sons
5. Energy management and good lighting practice: fuel efficiency- booklet12-EEO
6. Economic Analysis of Demand Side Programs and Projects - California Standard Practice Manual, June2002 – Free download available online

4.ELECTRICAL MEASUREMENTS AND INSTRUMENTATION

MODULE – 1 **Measurement of voltage & current** **10 hrs**

General principles of measurements –essentials of indicating instruments - deflecting, damping, controlling torques-Ammeters and voltmeters - moving coil, moving iron, constructional details, operation, Expression for deflecting & controlling torques and errors compensations- principles shunts and multipliers – extension of range.

MODULE -2 **Measurement of Power, Energy, Power factor** **10 hrs**

Power meters: Dynamometer type wattmeter –1-phase and 3-phase - LPF and UPF- Double Element and Three Element wattmeter's.
Energy meters: Single Phase Induction Type Energy Meter – Driving and Braking Torques – Errors and Compensations. Three Phase Energy Meter-TOD meter
P.F. Meters: Dynamometer and Moving Iron Type – 1-ph and 3-ph Meters.

MODULE-3 **Measurement of Resistance, Inductance and Capacitance** **9 hrs**

Measurement of Resistance: Kelvin's double bridge -Whetstone's bridge, sensitivity, limitations- loss of charge method -Megger method.
Measurement of Inductance and Capacitance: Maxwell's inductance and capacitance bridge-Hay's bridge- Anderson's bridge- Desauty's bridge -Schering bridge-weins bridge- Problems

MODULE-4 **Extension of Instrument Ranges** **9 hrs**

Instrument transformers: Current Transformers and Potential Transformers – Ratio and Phase Angle Errors – Methods for Reduction of Errors-Design Considerations.
Potentiometers: Principle and Operation of D.C. Crompton‟s Potentiometer – Standardization – Measurement of unknown Resistance, Current, Voltage -AC Potentiometers: Polar and Coordinate types-Standardization – Applications.

MODULE-5 **Transducers** **10 hrs**

Definition and classification - common transducers for measurement of displacement, velocity, flow, liquid level, force, pressure, strain and temperature -LVDT, electromagnetic and ultrasonic flow meters, piezoelectric force transducer, load cell, strain gauge- bridge configuration for four strain gauges, RTD, Thermistors, thermocouple, data acquisition system. **Total : 48 hrs**

Text Book(s):

1. Electrical & Electronic Measurements and Instrumentation by AK Sawhney, Dhanpat Rai & Sons Digital Instrumentation, A.J. Bouwens, Tata Mc-Graw hill.-2017
2. J. B. Gupta - A course in Electronic and Electrical measurements and Instrumentation, S. K. Kataria Publication-2020
3.Electrical Measurements & Measuring Instruments by M.L.Anand (Author)-2014

Reference Book(s):

1 Electrical Measurements and Measuring Instruments (English, Paperback, F. C. Widdis, E. W. Golding) January 2011
2. Electrical & Electronic Measurement & Instrumentation by R. K. Rajput, 2nd Edition, S. Chand & Co., 2nd Edition, 2013.

5. UTILIZATION OF ELECTRICAL ENERGY

MODULE – 1 Electric Drives and Traction 10 hrs

Fundamentals of electric drive - choice of an electric motor - application of motors for particular services traction generator set, traction motors, power transformers - characteristic features of traction motor - systems of railway electrification - electric braking - train movement and energy consumption - traction motor control - track equipment and collection gear

MODULE -2 Mechanics of Electric Traction 10 hrs

Mechanics of Train Movement. Speed-Time Curves of Different Services – Trapezoidal and Quadrilateral Speed-Time Curves – Numerical Problems. Calculations of Tractive Effort, Power, Specific Energy Consumption, Adhesive Weight and Coefficient of Adhesion.

MODULE-3 Illumination 10 hrs

Introduction - definition and meaning of terms used in illumination engineering - classification of light sources - incandescent lamps, sodium vapour lamps, mercury vapor lamps, fluorescent lamps –design of illumination systems - indoor lighting schemes - factory lighting halls - outdoor lighting schemes - flood lighting - street lighting – UPS-energy saving lamps, LED – working principle of air conditioning system.

MODULE-4 Heating And Welding 8 hrs

Introduction - advantages of electric heating – modes of heat transfer - methods of electric heating -resistance heating - arc furnaces - induction heating - dielectric heating - electric welding – types -resistance welding - arc welding - power supply for arc welding - radiation welding.

MODULE-5 Solar & Wind Energy Conversion System 10 hrs

Solar Energy Conversion System: Introduction - solar constant – terrestrial solar radiation - solar radiation geometry – estimation of average solar radiation - physical principles of the conversion of solar radiation into heat – flat-plate collectors - transmissivity of cover system - energy balance equation and collector efficiency - concentrating collector - advantages and disadvantages of concentrating collectors.

Wind Energy Conversion System: Introduction - basic principles of wind energy conversion - site selection considerations - basic components of a WECS (Wind Energy Conversion System) - Classification of WECS - types of wind machines - analysis of aerodynamic forces acting on the blade

Total : 48 hrs

Text Book(s):

1. Utilization of Electric Energy, E. Openshaw Taylor and V. V. L. Rao, Universities Press, 2009.

2. N.V. Suryanarayana, “Utilisation of Electric Power”, Wiley Eastern Limited, New Age International Limited, 1993

3. J.B.Gupta, “Utilisation Electric power and Electric Traction”, S.K.Kataria and sons, 2000.

Reference Book(s):

1. Generation, distribution and utilization of electrical energy, C.L Wadhwa, Wiley Eastern Limited,1993

2. R.K.Rajput, Utilisation of Electric Power, Laxmi publications private Limited.,2007

3. H.Partab, Art and Science of Utilisation of Electrical Energy", Dhanpat Rai and Co., New Delhi-2004.

4. G.D.Rai," Non-Conventional Energy sources", Khanna publications Ltd.,New Delhi 1997

6. INDUSTRIAL AUTOMATION ENGINEERING

MODULE – 1 FUNDAMENTAL CONCEPTS OF INDUSTRIAL AUTOMATION **10 hrs**

Definition of automation- Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Types of production and types of automation, automation strategies, levels of automation, Industrial bus systems: modbus & profibus

MODULE -2 AUTOMATION COMPONENTS **9 hrs**

Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

MODULE-3 PROGRAMMABLE LOGIC CONTROLLERS **10 hrs**

Introduction — Principles of operation – PLC Architecture and specifications – PLC hardware components Analog & digital I/O modules, CPU & memory module – Programming devices – PLC ladder diagram, Converting simple relay ladder diagram in to PLC relay ladder diagram. PLC programming Simple instructions – Manually operated switches – Mechanically operated a Proximity switches - Latching relays.

MODULE-4 APPLICATIONS OF PROGRAMMABLE LOGIC CONTROLLERS **9 hrs**

Timer instructions - On delay, Off delay, Cyclic and Retentive timers, Up /Down Counters, control instructions – Data manipulating instructions, math instructions; Applications of PLC – Simple materials handling applications, Automatic control of warehouse door, Automatic lubrication of supplier Conveyor belt, motor control, Automatic car washing machine, Bottle label detection and process control application.

MODULE-5 DISTRIBUTION AUTOMATION & SCADA **10 hrs**

DISTRIBUTION AUTOMATION: Distribution Automation (DA)-Benefits- Communication Technologies- Automatic Meter Reading(AMR)- Geographical Information System (GIS)- Consumer Information Service (CIS), Internet of things (IoT) for plant automation

SCADA: Introduction, Block Diagram, Components of SCADA, Functions of SCADA,SCADA applied to DA-Communication protocols in SCADA systems. **Total : 48 hrs**

Text Book(s):

1. Industrial Instrumentation and Control By. S.K. Singh The McGraw Hill Companies,2nd Edition 2003
2. Gary Dunning, Thomson Delmar,"Programmable Logic Controller", CeneageLearning,3rd Edition,2005.
3. Bolton , "Programmable Logic Controllers" 5th Edition Newnes, ,2009
4. Electric Power Distribution Automation, Dr. M. K. Khedkar and Dr. G. M. Dhole, University Science Press, 2010.
5. Electric Power Distribution, A.S. Pabla, Tata Mc Graw Hill (India) Pvt. Ltd., 6th Edition, 2011.

Reference Book(s):

1. C D Johnson, “Process Control Instrumentation Technology”, Prentice Hall India,8th Edition, 2006.
2. E.A.Parr, Newnes ,NewDelhi,“Industrial Control Handbook”,3rd Edition, 2000
3. Electric Power Distribution Engineering, Turan Gonen, CRC Press, 3rd Edition,2014.
4. Electrical Power Systems for Industrial Plants, Kamalesh Das, JAICO Publishing House, 2008.
5. Electrical Power Distribution Systems, V. Kamaraju, Jain Book Depot. 2012.

7.INDUSTRIAL ELECTRICAL SYSTEMS

MODULE – 1 **Electrical System Components** **10 hrs**

LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices

MODULE -2 **Residential and Commercial Electrical Systems** **10 hrs**

Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection Devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

MODULE-3 **Illumination Systems** **9 hrs**

Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.

MODULE-4 **Industrial Electrical Systems** **10 hrs**

HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction. Introduction to PCC, MCC panels. DG Systems, UPS System, ElectricalSystems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.

MODULE-5 **Industrial Electrical System Automation** **9 hrs**

Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation. **Total : 48 hrs**

Text Book(s):

1. S. L. Uppal and G. C. Garg, “Electrical Wiring, Estimating & Costing”, Khanna publishers, 2008.
2. K. B. Raina, “Electrical Design, Estimating & Costing”, New age International, 2007.

Reference Book(s):

1.S. Singh and R. D. Singh, “Electrical estimating and costing”, Dhanpat Rai and Co.,1997..
Web site for IS Standards.
2.. H. Joshi, “Residential Commercial and Industrial Systems”, McGraw Hill Education, 2008.

8. RENEWABLE ENERGY CONVERSION SYSTEMS

MODULE – 1 ENERGY CONSERVATION 10 hrs

Over view of conventional & renewable energy sources, need & development of renewable energy sources, types of renewable energy systems, Energy scenario — global and national; Renewable energy potential, Energy for sustainable development, Global climate change, concept of Hybrid systems.

MODULE -2 SOLAR & WIND ENERGY SOURCES 10 hrs

SOLAR ENERGY SOURCE: solar radiation, Measurements of Solar Radiation, Collectors, workingprinciple of photo voltaic cell, Equivalent Circuit model, Performance Characteristics, Applications.

WIND ENERGY SOURCE: Introduction, site selection considerations for installing wind mill, Construction details of the wind mill (Wind Turbine Gear System), Types of Wind Power Plants.

MODULE-3 THERMAL ENERGY & BIO-MASS 10 hrs

THERMAL ENERGY: Thermo-electric generator, Concepts and design considerations of MHDgenerators, Cycle analysis of MHD systems

BIO-MASS: Biomass resources and their classification, Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking.

MODULE-4 GEOTHERMAL ENERGY & OCEAN ENERGY 9 hrs

GEOTHERMAL ENERGY: Principle of geothermal energy, Resources, types of wells, methods of harnessing the energy, Economic Aspects, scope in India.

OCEAN ENERGY: Ocean Thermal Energy Conversion (OTEC), Principle of operation, development of OTEC plants, Tidal and wave energy.

MODULE-5 FUEL CELL ENERGY 9 hrs

Description, properties and operation of fuel cells, Major components & general characteristics offuel cells, Indirect methanol fuel cell systems. Phosphoric acid fuel cell systems and molten carbonate fuel cell systems, applications. **Total : 48 hrs**

Text Book(s):

1. Non conventional Energy sources, G.D. Rai, Khanna Publishers.
2. Renewable energy resources: Tiwari and ghosal, Narosa publication.
3. Renewable energy sources and conversion technology, Bansal Keemann, Meliss, Tata Mc Graw Hill
4.D.P.Kothari,Rakesh Ranjan and K.C.Singal,Renewable Energy Resources & Emerging Tech prentice Hall of India Pvt.Ltd
5.Non conventional energy resources "Prentice Hall Inc,India by Sawhney G.S

Reference Book(s):

1. Renewable Energy Sources: Twidell & Weir, CRC Press.
2. Solar Energy/ S.P. Sukhatme, Tata McGraw-Hill.
3. Non Conventional Energy Systems: K M. Mittal, A H WheelerPublishing Co Ltd.
4. Renewable Energy Technologies: Ramesh & Kumar, Narosa publication. 5. Biomass Energy, Oxford& IBH Publication Co.

9. POWER QUALITY

MODULE – 1 **Introduction** 10 hrs

Definition of Power Quality- Power Quality Terminology – Classification of Power Quality Issues-Magnitude Versus Duration Plot - Power Quality Standards - Responsibilities of Suppliers and Users of Electric Power-CBEMA and ITI Curves.

MODULE -2 **Transients, Short Duration and Long Duration Variations** 10 hrs

Categories and Characteristics of Electromagnetic Phenomena in Power Systems- Impulsive and Oscillatory Transients-Interruption - Sag-Swell-Sustained Interruption - Under Voltage – Over Voltage–Outage. Sources of Different Power Quality

Disturbances- Principles of Regulating the Voltage- Conventional Devices for Voltage Regulation.

MODULE-3 **Fundamentals Of Harmonics & Applied Harmonics** 10 hrs

Harmonic Distortion, Voltage Versus Current Distortion, Harmonics Versus Transients, Power System Quality Under Non Sinusoidal Conditions, Harmonic Indices, Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads. Applied

Harmonics**:** Effects Of Harmonics, Harmonic Distortion Evaluations, Principles of Controlling Harmonics, Devices for Controlling Harmonic Distortion.

MODULE-4 **Power Quality Monitoring** 10 hrs

Power Quality Benchmarking-Monitoring Considerations- Choosing Monitoring Locations-Permanent Power Quality Monitoring Equipment-Historical Perspective of Power Quality Measuring Instruments- Power Quality Measurement Equipment-Types of Instruments-Assessment of Power Quality Measurement Data- Power Quality Monitoring Standards.

MODULE-5 **Power Quality Enhancement Using Custom Power Devices** 8 hrs

Introduction to Custom Power Devices-Network Reconfiguring Type: Solid State Current Limiter (SSCL)-Solid State Breaker (SSB) –Solid State Transfer Switch (SSTS) – Compensating Type: Dynamic Voltage Restorer (DVR)-Unified Power Quality Conditioner(UPQC)-Principle of Operation Only.

Total : 48 hrs

Text Book(s):

1. Electrical Power Systems Quality, Roger C. Dugan, Mark F. McGranaghan, Surya Santoso, H.Wayne Beaty, Mc Graw Hill Education (India) Pvt. Ltd., 3rd Edition, 2012.

2. Power quality, C. Sankaran, CRC Press, 2001.

3. J.Arillaga, N.R.Watson and S.Chen, “Power System Harmonics”, John Wiley and Sons,

England, 2005

Reference Book(s):

1. Understanding Power quality problems – Voltage Sags and Interruptions, Math H. J. Bollen IEEE Press Series on Power Engineering, WILEY, 2007.

2. Power quality – VAR Compensation in Power Systems, R. Sastry Vedam, Mulukutla S. Sarma, CRC Press, 2009, First Indian Reprint 2013.

3. Fundamentals of Electric Power Quality, Surya Santoso, Create Space, 2012.