Vel Tech
Rangarajan Dr. Sagunthala
R&D Institute of Science and Technology
(Deemed to be University Estd. u/s 3 of UGC Act, 1956)

SCHOOL OF ELECTRICAL & COMMUNICATION

B.TECH. DEGREE PROGRAMME

ELECTRICAL AND ELECTRONICS ENGINEERING

VTUR-15 REGULATIONS 2015

VISION & MISSION OF THE UNIVERSITY

Vision:

To create, translate and disseminate frontiers of knowledge embedded with creativity and innovation for a positive transformation of emerging society.

Mission:

To nurture excellence in teaching, learning, creativity and research; translate knowledge into practice; foster multidisciplinary research across science, medicine, engineering, technology and humanities; incubate entrepreneurship; instill integrity and honor; inculcate scholarly leadership towards global competence and growth beyond self in a serene, inclusive and free academic environment.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION AND MISSION OF THE DEPARTMENT

Vision:

To provide intellectual curiosity in the field of Electrical and Electronics Engineering that produces skilled interdisciplinary engineers to serve the society.

Mission:

M1	To inculcate knowledge among the students through comprehensive curriculum.
M2	To enrich the academic experience in terms of flexibility, teamwork, design skills, practice and industrial trainings.
M3	To produce competent graduates suitable for a successful career in Industry and Research

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

On successful completion of graduation, graduates will be able to

PEO1	Design and analyse electrical and electronic systems by applying the knowledge of mathematics and engineering
PEO2	Provide practical solution to multidisciplinary societal problems through innovative ideas
PEO3	Secure positions and continue as valued, creative and proficient employees in a wide variety of fields and industries for a rewarding career

PROGRAMME OUTCOMES (POs):

The Electrical and Electronics Engineering Graduates will be able to:

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

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

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

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

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

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

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

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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

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

PROGRAMME SPECIFIC OUTCOME (PSOs):

PSO1. Apply fundamental of mathematics, physical sciences and electrical & electronics engineering to analyze and solve complex real world problems.

PSO2. Design, develop and implement electrical, electronics and allied engineering systems to meet the demands of industry and suggest solutions for social needs**.**

Minimum credits required in course categories

Course Category	Minimum Credits Required
Foundation courses	60
Programme core	60
Programme elective	18
Allied elective	6
University elective	10
Value education elective	4
Independent learning	20
Industry/Higher Institute Learning Interaction	2
Total	**180**

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VTUR15 EEE Curriculum

Programme Core (PC) Courses

Sl.No	Course Code	Lecture Courses	L	T	P	C
1	1151EE101	Circuits Analysis	3	0	0	3
2	1151EE102	Electronic Devices & Circuits	3	0	0	3
3	1151EE103	DC Machines & Transformers	3	0	0	3
4	1151EE104	AC Machines	3	0	0	3
5	1151EE105	Digital Electronics	3	0	0	3
6	1151EE106	Control Systems	2	2	0	3
7	1151EE107	Measurements and Instrumentation	2	0	0	2
8	1151EE108	Transmission & Distribution	3	0	0	3
9	1151EE109	Power Electronics	2	2	0	3
10	1151EE110	Power System Analysis	3	0	0	3
11	1151EE111	Power System Operation & Control	3	0	0	3
12	1151EE112	Electrical Machine Design	3	0	0	3
13	1151EE113	Microprocessor & Microcontroller	3	2	0	4
14	1151EE114	Discrete Time Signal Processing	3	0	0	3
15	1151EE115	Linear Integrated Circuits	3	0	0	3
16	1151EE116	Numerical Methods	3	0	0	3
Integrated Courses						
17	1151EE201	Electromagnetic Fields	2	0	2	3
Laboratory Courses						

Sl.No	Course Code	Lecture Courses	L	T	P	C
18	1151EE301	Circuit Analysis Lab	0	0	2	1
19	1151EE302	Electronic Devices & Circuits Lab	0	0	2	1
20	1151EE303	DC Machines & Transformers Lab	0	0	2	1
21	1151EE304	AC Machines Lab	0	0	2	1
22	1151EE305	Control & Instrumentation Lab	0	0	2	1
23	1151EE306	Microprocessor & Microcontroller Lab	0	0	2	1
24	1151EE307	Discrete Time Signal Processing Lab	0	0	2	1
25	1151EE308	Power Electronics & Drives Lab	0	0	2	1
26	1151EE309	Power System Simulation Lab	0	0	2	1
		Total				**60**

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VTUR15 EEE Curriculum

Programme Elective (PE) Courses

Sl.No.	Course Code	Lecture Courses	L	T	P	C
Power Systems						
1	1152EE101	Power Quality Engineering	3	0	0	3
2	1152EE102	Protection and Switchgear	3	0	0	3
3	1152EE104	High Voltage Engineering	3	0	0	3
4	1152EE105	Advances in Power System	3	0	0	3
5	1152EE106	Smart Grid	3	0	0	3
6	1152EE107	Power Plant Engineering	3	0	0	3
7	1152EE108	High Voltage Direct Current Transmission	3	0	0	3
8	1152EE109	Load Forecasting and Generation Forecasting	3	0	0	3
9	1152EE110	Load Dispatching	3	0	0	3
10	1152EE144	Reactive Power Management	3	0	0	3
Power Electronics & Drives						
11	1152EE111	LED Lighting Technology	3	0	0	3
12	1152EE112	Flexible AC Transmission Systems	3	0	0	3
13	1152EE113	Modern Power Converters	3	0	0	3
14	1152EE114	Automotive Electrical & Electronics Systems	3	0	0	3
15	1152EE115	Fundamentals of Electric and Hybrid Vehicles	3	0	0	3
16	1152EE116	Special Electrical Machines	3	0	0	3
17	1152EE117	Electromagnetic Interference & Compatibility	3	0	0	3
18	1152EE118	Solid State Drives	3	0	0	3
Embedded Systems						
19	1152EE119	Principles of Robotics	3	0	0	3
20	1152EE120	Embedded Systems	3	0	0	3

Sl.No.	Course Code	Lecture Courses	L	T	P	C
21	1152EE121	Embedded control of Electric Drives	3	0	0	3
22	1152EE122	VLSI System & Design	3	0	0	3
23	1152EE142	Wearable Electronics	3	0	0	3
Instrumentation & Control						
24	1152EE123	Virtual Instrumentation	3	0	0	3
25	1152EE124	Digital Control Systems	3	0	0	3
26	1152EE125	Introduction to Nonlinear Dynamical Systems	3	0	0	3
27	1152EE126	Network Analysis & Synthesis	3	0	0	3
28	1152EE127	Signals and Systems	3	0	0	3
29	1152EE128	Soft Computing	3	0	0	3
30	1152EE129	Bio Medical Instrumentation	3	0	0	3
31	1152EE130	Process Automation	3	0	0	3
Energy						
32	1152EE132	Utilization of Electrical Energy	3	0	0	3
33	1152EE133	Energy Auditing and Management	3	0	0	3
34	1152EE134	Electrical Safety & Quality Management	3	0	0	3
35	1152EE135	Renewable Energy Sources	3	0	0	3
36	1152EE136	Solar Electric Systems	3	0	0	3
37	1152EE137	Wind Energy Conversion Systems	3	0	0	3
38	1152EE138	Generation Planning	3	0	0	3
39	1152EE143	Solar Photovoltaic Systems	2	0	2	3
Integrated Course						
40	1152EE201	Applied Soft Computing	2	0	2	3
41	1152EE202	Switch Mode Power Supply Design and Development	4	0	4	6
Laboratory Course						
42	1152EE301	Voltage Stabilizer Fabrication	0	0	2	1

PROGRAMME CORE COURSES

THEORY COURSES

COURSE CODE:**1151EE101**	COURSE TITLE: **CIRCUIT ANALYSIS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Core

PREAMBLE: This course aims to develop the necessary fundamentals for Electrical and Electronics engineers to analyze and solve a simple circuit involving DC and AC by making use of network laws and theorems. This course also provides a basic and comprehensive knowledge of circuits involving three phase, resonance, coupled and transients which an electrical engineer will come across in many applications and provide their solution.

PREREQUISITE COURSES: Basic Electrical Engineering

RELATED COURSES: Linear Integrated Circuits

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand the significance of the basic terminologies in electrical circuits and relation between the electrical quantities of R, L and C.
- Be proficient in handling basic laws and theorems in solving circuits.
- Be familiar with network topology and two port networks.
- Understand coupled and three phase circuits.
- Analyse the effect of transients and resonance.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the basic laws and theorems for a given circuit involving DC and AC	K2
CO2	Apply network theorems for DC and AC circuits	K3
CO3	Build the network graph and network parameters for a given circuit	K3
CO4	Solve coupled and three phase circuits	K3
CO5	Identify circuits involving transients and resonance	K3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	L						L	L	H	L
CO2	H	H	H	M	L						L	L	H	L
CO3	H	H	H	M	L						L	L	H	L
CO4	H	H	H	M	L						L	L	H	L
CO5	H	H	H	M	L						L	L	H	L

COURSE CONTENT :		
UNIT I	**BASIC CIRCUIT ANALYSIS**	**9**
Review of circuit elements – types of electric circuits, types of voltage and current source, Kirchhoff's Laws, Mesh current and Node voltage analysis for DC and AC circuits, super mesh and super node		
UNIT II	**NETWORK THEOREMS**	**9**
Superposition theorem - Thevenin's theorem - Norton's theorem - Maximum power transfer theorem - Reciprocity theorem.		
UNIT III	**NETWORK TOPOLOGY AND TWO PORT NETWORKS**	**9**
Network topology, Incidence matrix, Tie-set matrix, Cut-set matrix, Dual networks - Two port network, Impedance Parameter, Admittance Parameter, Transmission line.		
UNIT IV	**COUPLED AND THREE PHASE CIRCUITS**	**9**
Self and Mutual inductance - Coefficient of coupling-Analysis of coupled circuits - Analysis of single tuned circuits, Solution of circuits with balanced and unbalanced loads - Power measurement by two wattmeter method.		
UNIT V	**CIRCUIT TRANSIENTS AND RESONANCE**	**9**
Transient response of RL, RC and RLC circuit using Laplace transform, Series and parallel resonance, quality factor for series and parallel resonance circuit, bandwidth and resonant filters.		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", Tata McGraw Hill Publishers, 6th edition, New Delhi, 2003.
2. Joseph A. Edminister, Mahmood Nahri, "Electric circuits", Schaum's series, Tata McGraw-Hill, New Delhi, 2001.

REFERENCE BOOKS:

1. Paranjothi SR, "Electric Circuits Analysis," New Age International Ltd., New Delhi, 1996.
2. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", Tata McGraw Hill, 2007.
3. Chakrabati A, "Circuits Theory (Analysis and synthesis), Dhanpath Rai & Sons, New Delhi, 1999.
4. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", Second Edition, McGraw Hill, 2003.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/108105159

COURSE CODE: **1151EE102**	COURSE TITLE: **ELECTRONIC DEVICES AND CIRCUITS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Core

PREAMBLE: This course aims to provide the basic operation, characteristics of electronic devices and analysing the performance of electronic circuits by implementing the devices.

PREREQUISITE COURSES:

Basic Electrical Engineering, Basic Electronics Engineering

RELATED COURSES: Linear Integrated Circuits, Power Electronics and Drives, Digital Electronics, Microprocessors and Microcontrollers

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand the basic structure and operation of PN Junction devices
- Illustrate the types of rectifier, filters and regulators
- Understand the construction, operation and characteristics of Bipolar Junction Transistor**,** Field Effect Transistor and Multi-vibrators.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the structure, operation and characteristics of PN Junction devices	K2
CO2	Summarize the types of rectifier, filters and regulators	K2
CO3	Illustrate the operation and characteristics of Bipolar Junction Transistor	K2
CO4	Explain the structure, operation and characteristics of Field Effect Transistor.	K2
CO5	Construct the oscillators, Mutivibrators and power amplifiers for given applications.	K3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M			L								H	L
CO2	H	M			L								H	L
CO3	H	M			L								H	L
CO4	H	M			L								H	L
CO5	H	H	H	M	L	L					L	L	H	H

COURSE CONTENT:		
UNIT I	**PN JUNCTION DEVICES**	**9**
PN junction diode – structure, operation and V-I characteristic-current equation of drift current density and diffusion current density - diffusion and transient capacitance – introduction to SCR, DIAC,TRIAC and UJT - display devices- LED, Laser diodes, Zener breakdown - zener reverse characteristic.		
UNIT II	**RECTIFIERS, FILTERS AND REGULATORS**	**9**
Half wave rectifier, ripple factor, full wave rectifier, Harmonic components in a rectifier circuit, clipper and clamper circuit and types, Inductor filter, Capacitor filter, LC - filter, Pi - section filter, and comparison of various filter circuits in terms of ripple factors, Simple circuit of a regulator using zener diode.		
UNIT III	**BIPOLAR JUNCTION TRANSISTORS**	**9**
BJT structure, operation and V-I characteristic- BJT small signal model – biasing – analysis of CE, CB, CC amplifiers - Gain and frequency response. BJT biasing, DC load line, fixed bias, Collector to base bias, self bias techniques for stabilization, comparison of Biasing Techniques		
UNIT IV	**FET CHARACTERISTICS**	**9**
MOSFET – structure, operation and V-I characteristic – types of MOSFET –MOSFET small signal model – biasing – analysis of CS and source follower – gain and frequency response- JFET – structure, operation and V-I characteristic. Introduction of IGBT, comparison of all transistors		
UNIT V	**OSCILLATORS, MULTIVIBRATORS, POWER AND FEED BACK AMPLIFERS**	**9**
Condition for oscillations, phase shift – Wien Bridge, Hartley, Colpitts and Crystal Oscillators - UJT as relaxation oscillator. Multivibrators - Astable, Monostable and Bistable, CLASS A, B, AB, C and D power amplifiers. Feedback amplifiers and its types		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. V.K. Metha, " Principles of Electronics"
2. David A. Bell, "Electronic devices and circuits", Oxford University, 5th Edition, 2009.
3. Sedra Smith, "Microelectronic circuits "Oxford University Press, 5th Edition 2011.

REFERENCE BOOKS:

1. Floyd, "Electron devices" Pearson Asia 5th Edition, 2011.
2. Donald A Neamen, "Electronic Circuit Analysis and Design" Tata McGraw Hill, 3rd Edition 2012.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/108105158

COURSE CODE: **1151EE103**	COURSE TITLE: **DC MACHINES & TRANSFORMERS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Core

PREAMBLE: This course provides an introduction to the basic concepts of rotating machines, DC Machines (Generators and motors), transformers and their testing methods, emphasizing their inter-relations and applications to engineering, and research areas; introduce students to cognitive learning and develops problem solving skills with both theoretical and engineering oriented problems.

PREREQUISITE COURSES:

Basic Electrical Engineering

RELATED COURSES:

AC Machines, Electrical Machine Design

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Provide the basic concept of DC machines and Transformers.
- Develop the skills of the students in the areas of machines and transformers by identifying the current problem in the industries and bring solutions through research.
- Diagnose the condition of DC machines and Transformers.

COURSE OUTCOMES :

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

CO Nos	Course Outcomes	Level of learning domain (Based on revised Bloom's taxonomy)
CO1	Elaborate the principle of electromagnetic energy conversion.	K2
CO2	Explain the performance characteristics of DC Generators.	K2
CO3	Describe the performance characteristics of DC Motors.	K2
CO4	Describe the equivalent circuit of transformers and determine its regulation	K2
CO5	Realize the testing methods to determine the performance characteristics of DC machines and Transformers.	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H		L			L				L	L	M	L
CO2	H	H		M							L	M	H	L
CO3	H	H		M							L	M	H	L
CO4	H	H		M							L	M	H	L
CO5	H	H	L	M							L	M	H	L

COURSE CONTENT:		
UNITI	**BASIC CONCEPTS OF ROTATING MACHINES**	**6**
Principles of electromechanical energy conversion – Force and Torque equations in magnetic fields – Energy and Force in single and multiple excited systems – Concept of Co-energy – mmf of distributed windings – Rotating magnetic field – Generated voltage - Torque in Wound rotor machine.		
UNITII	**DC GENERATORS**	**12**
Constructional details – Principle of Operation – Action of Commutator – Armature windings – lap and wave windings – Simplex and Multiplex windings – use of Laminated Armature – emf equation – Armature Reaction (cross Magnetizing and de-magnetizing AT/Pole) – compensating winding – Commutation – methods of improving Commutation - Methods of excitation – self and separately excited generators – Parallel operation of dc shunt and compound generators.		
UNITIII	**DC MOTORS**	**9**
Principle of operation – Back emf and torque equation – Characteristics and application of series, shunt and compound motors – starting of dc motors – Types of starters – Speed control of dc shunt and series motors – Braking of dc shunt motor – Protecting devices.		
UNITIV	**TRANSFORMERS**	**9**
Constructional details of core and shell type transformers- Types of winding - Principle of operation - emf equation- Transformation ratio - Transformer on no-load - Parameters referred to HV/LV windings - Equivalent circuit - Transformer on load- Regulation - Parallel operation of single and three phase transformers - Auto transformer- Three phase transformers – Phasor diagram – Load Sharing of Transformer.		
UNIT V	**TESTING OF DC MACHINES AND TRANSFORMERS**	**9**
Losses and efficiency in DC machines and transformers - Condition for maximum efficiency - Testing of DC machines – Brake test, Swinburne's test, Sumpner's test, Retardation Test, Hopkinson's test – testing of transformers – Polarity test, load test, open circuit and short circuit tests, Tan Delta tests - All day efficiency.		
		TOTAL: 45 PERIODS
TEXTBOOKS:		
1. Dr.P.S.Bimbhra, 'Electrical Machinery', Khanna Publishers, 7th Edison, 2013. 2. D.P.Kothari and I.J.Nagrath, 'Electric Machines', Tata McGraw Hill Publishing company Ltd, 2002.		
REFERENCE BOOKS:		
1. A.E.Fitzgerald, Charles Kingsley, Stephen.D.Umans, 'Electric Machinery', and Tata McGraw Hill Publishing company Ltd, 2003. 2. J.B.Gupta, 'Theory and performance of Electrical Machines', S.K.Kataria and sons, 2002.		
ONLINE RESOURCES:		
1. https://onlinecourses.nptel.ac.in/noc22_ee111/preview		

COURSE CODE: **1151EE104**	COURSE TITLE: **AC MACHINES**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Core

PREAMBLE: This course provides knowledge on various types of AC Generator, AC Motor and recent Special Machines, which mould the students in relation to the performance characteristics, operating principle, control techniques and their applications.

PREREQUISITE COURSES: DC Machines & Transformers

RELATED COURSES: Solid State Drives

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Analyse the performance characteristics of Synchronous machines
- Explain the performance characteristics of Induction machines.
- Summarize the concept of Single Phase Induction Motors and Special Machines.

COURSE OUTCOMES :

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

CO No.	Course Outcomes	Level of learning domain (Based on revised Bloom's taxonomy)
CO1	Explain the operating principle, methods of determining regulation of three phase alternator	K2
CO2	Analyse the characteristics of synchronous motors	K4
CO3	Explain the performance characteristics of 3 phase Induction Motor	K2
CO4	Analyze the control strategies of 3 phase Induction Motor	K4
CO5	Illustrate the operating principle of Single Phase Induction motors and Special Machines.	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H		L		L						L	H	L
CO2	H	H		M									H	L
CO3	H	H	M	M			L						H	L
CO4	H	H		M									H	L
CO5	H	M		M		M						L	H	L

COURSE CONTENT:

UNIT I	**SYNCHRONOUS GENERATOR**	**9**

Constructional details – Types of rotors – emf equation – Synchronous reactance – Armature reaction – Voltage regulation – E.m.f, mmf, z.p.f and A.S.A methods – Synchronizing and parallel operation – Synchronizing torque - Change of excitation and mechanical input – Two reaction theory – Determination of direct and quadrature axis synchronous reactance using slip

test – Operating characteristics - Capability curves.		
UNIT II	**SYNCHRONOUS MOTOR**	**9**
Principle of operation – Torque equation – Operation on infinite bus bars - V-curves – Power input and power developed equations – Starting methods – Current loci for constant power input, constant excitation and constant power developed.		
UNIT III	**THREE PHASE INDUCTION MOTOR**	**9**
Rotating magnetic field-Constructional details – Types of rotors – Principle of operation – Slip – Equivalent circuit – Slip-torque characteristics - Condition for maximum torque – Losses and efficiency – Load test - No load and blocked rotor tests - Circle diagram – Separation of no load losses – Double cage rotors – Induction generator – Synchronous induction motor.		
UNIT IV	**STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR**	**9**
Need for starting – Types of starters – Stator resistance and reactance, rotor resistance, autotransformer and star-delta starters – Speed control – Change of voltage, torque, number of poles and slip – Cascaded connection – Slip power recovery scheme		
UNIT V	**SINGLE PHASE INDUCTION MOTORS**	**9**
Constructional details of single phase induction motor – Double revolving field theory and operation – Equivalent circuit – No load and blocked rotor test – Performance analysis – Starting methods of single-phase induction motors - Shaded pole induction motor, reluctance motor, repulsion motor, hysteresis motor, stepper motor and AC series motor.		
		TOTAL: 45 PERIODS
TEXTBOOKS:		
1. D.P. Kothari and I.J. Nagrath, 'Electric Machines', Tata McGraw Hill Publishing Company Ltd, 2010. 2. B. L. Theraja and A.K. Theraja, "A Text Book of Electrical Technology", S. Chand Publication, 2002.		
REFERENCE BOOKS:		
1. A.E. Fitzgerald, Charles Kingsley, Stephen.D.Umans, 'Electric Machinery',TataMcGraw Hill publishing Company Ltd, 2002. 2. J.B. Gupta, 'Theory and Performance of Electrical Machines', S.K.Kataria and Sons, 2009. 3. K. Murugesh Kumar, 'Electric Machines', Vikas publishing house Pvt Ltd, 2004. 4. Sheil1.C.Haran, 'Synchronous, Induction and Special Machines', Scitech Publications, 2001. 5. P.S. Bhimbhra, 'Electrical Machinery', Khanna Publishers, 2003.		
ONLINE RESOURCES:		
1. https://nptel.ac.in/courses/108105131		

COURSE CODE: **1151EE105**	COURSE TITLE: **DIGITAL ELECTRONICS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Core

PREAMBLE: The primary aim of this course is to understand the fundamental behind digital logic circuit design and gain experience in using them for meeting any design specification. This course includes fundamentals of Boolean algebra, combinational circuits, sequential circuits, introduction to VHDL and applications of digital electronics.

PREREQUISITE COURSES: Basic Electrical Engineering, Electronic Devices and Circuits

RELATED COURSES: Microprocessor and Microcontroller, VLSI System & Design

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Familiar with number systems, number conversions and simplification using Boolean algebra.
- Understand combinational and sequential digital logic circuits.
- Write the code for digital logic circuits using Verilog HDL.
- Study the applications of digital electronics.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Apply the fundamentals of digital electronics for designing combinational circuits.	K3
CO2	Develop synchronous sequential circuits for given applications.	K3
CO3	Implement the Structural, Dataflow and Behavioral modeling for combinational and sequential circuits using hardware description language.	K3
CO4	Develop asynchronous sequential circuits for given applications.	K3
CO5	Explain the applications of digital electronics.	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	M	M							M	H	M
CO2	H	H	H	H	M						L	M	H	M
CO3	H	H	H	H	M						L	M	H	M
CO4	H	H	H	H	M						L	M	H	M
CO5	M	L				L						L	L	L

COURSE CONTENT:		
UNIT I	**DIGITAL FUNDAMENTALS AND COMBINATIONAL CIRCUITS**	**9**
Introduction to Boolean algebra and Switching Functions; Boolean Minimization using K Map and Tabulation method; combinational circuits: Design procedure – Half adder – Full Adder – Half subtractor – Full subtractor – Parallel binary adder, parallel binary Subtractor – Fast Adder - Carry Look Ahead adder – Serial Adder/Subtractor - BCD adder – Binary Multiplier – Binary Divider - Multiplexer/ Demultiplexer – decoder - encoder – parity checker – parity generators – code converters - Magnitude Comparator.		
UNIT II	**SEQUENTIAL CIRCUITS**	**9**
Flip Flops and Memory devices: RAM – Static and Dynamic, ROM, PROM, EPROM, EEPROM - Counters and Shift registers - Binary, BCD and programmable modulo counters, Shift register counters - Sequential circuit design: using Mealy and Moore model.		
UNIT III	**INTRODUCTION TO HARDWARE DESCRIPTION LANGUAGE**	**9**
Introduction to Verilog / VHDL - Structural, Dataflow and Behavioral modeling - Structural, Dataflow and Behavioral modeling of combinational logic circuits (Multiplexer, Demultiplexer, decoder and encoder) - Structural, Dataflow and Behavioral modeling of sequential logic circuits (counters and shift registers).		
UNIT IV	**ASYNCHRONOUS SEQUENTIAL CIRCUITS**	**9**
Analysis Procedure, Circuits with latches - Design Procedure - Reduction of state and flow table - Race free state assignment – Hazards - ASM chart - Design examples.		
UNIT V	**APPLICATIONS OF DIGITAL ELECTRONICS**	**9**
Multiplexing displays - Frequency counters - Time measurements - using the ADC0804 - Slope alone operation, span adjust, zero shift, testing - microprocessor compatible A/D converters.		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. M. Morris Mano, Digital Design, 3rd Edition, Prentice Hall of India Pvt. Ltd., 2003 / Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2003. 2. Donald .P.Leach, Digital principles and applications,7th Edition,McGraw-Hill ,2012		
REFERENCE BOOKS:		
1. John F.Wakerly, Digital Design, Fourth Edition, Pearson/PHI, 2006. 2. Thomas L. Floyd, Digital Fundamentals, 8th Edition, Pearson Education Inc, New Delhi, 2003 Donald D.Givone, Digital Principles and Design, TMH. 3. William H. Gothmann, Digital Electronics, 2nd Edition, PHI, 1982.		
ONLINE RESOURCES:		
1. https://onlinecourses.nptel.ac.in/noc22_ee110/preview		

COURSE CODE: **1151EE106**	COURSE TITLE: **CONTROL SYSTEMS**	L	T	P	C
		2	**2**	**0**	**3**

COURSE CATEGORY: Program Core

PREAMBLE :

This course aims to provide knowledge in mathematical modelling with state space and transfer function models, time and frequency response analysis and stability studies of the system.

PREREQUISITE COURSES: Circuit Analysis

RELATED COURSES: Digital Control Systems

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Acquire knowledge in mathematical modelling of various systems.
- Perform time and frequency domain analysis and the check the stability.
- Apply controllers and compensators design for the system based on given specifications.
- Develop state space model from transfer function.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Develop mathematical Model for electrical, mechanical and Electro mechanical systems and Obtain transfer function using block diagram algebra and mason's gain formula	K2
CO2	Calculate various time domain specifications and describe their significance	K2
CO3	Analyze the Performance of The given System using frequency response plots and root locus	K3
CO4	Determine the stability of the given system using time and frequency domain approach	K3
CO5	Identify suitable compensator based on given specifications and Explain the concept of P,PI and PID Controllers	K3
CO6	Develop state space models from transfer functions and vice versa	K3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M		L						L	M	H	M
CO2	H	H	L		M							M	H	M
CO3	H	H	H	M	M						M	M	H	M
CO4	H	H	M									M	H	M
CO5	H	H	M	M	M						M	M	H	M
CO6	H	H	M								L	M	H	M

COURSE CONTENT:		
UNIT I	**INTRODUCTION**	**9**
Introduction to control systems – Open loop and closed loop systems – Mathematical modelling of various systems – analogies between Electrical and Mechanical Systems – Determination of transfer function using Block Diagram Reduction – Signal flow graph Method		
UNIT II	**TIME RESPONSE ANALYSIS**	**9**
Poles – Zeros - Effect of feedback – Standard Test Signals – Time Response of First order and Second order systems – Time response specifications – Effects of addition of Poles and Zeros - Steady State errors and error constants - P PI and PID Controllers an Introduction		
UNIT III	**FREQUENCY RESPONSE ANALYSIS**	**9**
Introduction to frequency response-Time and frequency response correlation (Excluding proof) – Polar plot – Bode plot – Frequency response specification -Gain margin and phase margin-Design of Lag and Lead compensators using frequency response specifications		
UNIT IV	**STABILITY ANALYSIS**	**9**
Stability concepts – Conditions for stability – Routh Hurwitz stability criteria - Root locus method – Stability in frequency domain – Nyquist stability criterion – Relative stability analysis		
UNIT V	**INTRODUCTION TO STATE SPACE MODEL**	**9**
Introduction to State space – State Equations – Conversion of State space model to transfer function and vice versa - Solution of State Equations - State Transition Matrix – Controllability and Observability.		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Norman.S.Nise “Control Systems Engineering” , Wiley Student Edition, 5th edition 2012
2. RicharD.C.Dorf and Robert.H.Bishop “Modern Control Sytems”, Pearson Education,11th edition 2011.
3. IJ Nagrath and M.Gopal “Control Systems Engineering”, New Age International, 6th edition 2010.

REFERENCE BOOKS:

1. Kaitshiko Ogata “Modern Control Engineering”Pearson Education” 2010 edition.
2. John J Azzo and Constantine H.Houpis “Linear Control Systems analysis and Design with MATLAB”, Marcel Dekker Inc, 6th Edition 2013.
3. Graham C. Goodwin, Stefen F. Grebe and Mario E.Salgado “Control System Design”, PHI,2002.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/108106098

COURSE CODE: **1151EE107**	COURSE TITLE: **MEASUREMENTS AND INSTRUMENTATION**	L	T	P	C
		2	**0**	**0**	**2**

COURSE CATEGORY: Program Core

PREAMBLE : This course provide adequate knowledge in electrical and electronic instruments and measurements techniques

PREREQUISITE COURSES:

Basic Electrical Engineering

RELEVANT COURSES:

Power Electronics

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand general instrumentation system, error and calibration
- Understand analog and digital techniques to measure voltage, current, energy and power
- Compare AC and DC bridges and also analyse grounding methods.
- Elaborate discussion about storage & display devices.
- Study different transducers and data acquisition system

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain about calibration, classify errors and standards	K2
CO2	Illustrate types of electrical and electronic instruments	K2
CO3	Explain about types of bridges required for measurements and also explain the concept of earth loop current	K2
CO4	Explain about types of display measurement devices	K2
CO5	Explain the types of transducers required for energy conversion	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H										L	H	L
CO2	H	H										L	H	L
CO3	H	H										L	H	L
CO4	H	H										L	H	L
CO5	H	H										L	H	L

COURSE CONTENT:		
UNIT I	**INTRODUCTION**	**6**
Functional elements of an instrument – Static and dynamic characteristics – Errors in measurement – Statistical evaluation of measurement data – Standards and calibration		
UNIT II	**ELECTRICAL AND ELECTRONICS INSTRUMENTS**	**6**
Principle and types of analog and digital voltmeters, ammeters, multimeters – Single and three phase wattmeters and energy meters -Instrument transformers – Instruments for measurement of frequency and phase.		
UNIT III	**COMPARISON METHODS OF MEASUREMENT**	**6**
D.C & A.C potentiometers, D.C & A.C bridges, transformer ratio bridges, self-balancing bridges. Multiple earth and earth loops - Electrostatic and electromagnetic interference – Grounding techniques		
UNIT IV	**STORAGE AND DISPLAY DEVICES**	**6**
Magnetic disk and tape – Recorders, CRT display, digital CRO, LED, LCD & dot matrix display.		
UNIT V	**TRANSDUCERS AND DATA ACQUISITION SYSTEMS**	**6**
Classification of transducers – Selection of transducers – Resistive, capacitive & inductive transducers – Temperature transducers - Thermister, Thermocouple - LVDT, Pressure transducer r– Strain gauges – Piezo electric – Elements of data acquisition system – A/D, D/A converters.		
		TOTAL: 30 PERIODS
TEXT BOOKS:		
1. E.O. Doebelin, 'Measurement Systems – Application and Design', Tata McGraw Hill publishing company, 2003. 2. A.K. Sawhney, 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2004.		
REFERENCE BOOKS:		
1. D.V.S. Moorthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2003. 2. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw Hill, 1995. 3. Martin Reissland, 'Electrical Measurements', New Age International (P) Ltd., Delhi, 2001. 4. J. B. Gupta, 'A Course in Electronic and Electrical Measurements', S. K. Kataria & Sons, Delhi, 2003. 5. David A Bell, Electronic Instrumentation and Measurement, Third Edition, Oxford University Press, 2008.		
ONLINE RESOURCES:		
1. https://onlinecourses.nptel.ac.in/noc22_ee112/preview		

COURSE CODE: **1151EE108**	COURSE TITLE: **TRANSMISSION AND DISTRIBUTION**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Core

PREAMBLE: This course helps to familiar with the estimation of different line parameters in Transmission lines of power systems, modelling of the transmission lines for computing performance parameters, performance of insulators used in transmission lines and determining the voltage drop in various type of distributers.

PREREQUISITE COURSES:

Electromagnetic fields, Circuit Analysis

RELATED COURSES:

Power System Analysis, Power System Operation & Control

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to:

- Determine the single and three phase transmission line parameters.
- Obtain the equivalent circuits of the transmission lines for determining voltage regulation and efficiency.
- Acquire knowledge on mechanical design of overhead lines and insulators.
- Understand the types of underground cables.
- Calculate the voltage drop on DC and AC distributors.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Construct the transmission line models and solve for its performance parameters.	K3
CO2	Develop the equivalent circuits for the transmission lines based on distance and determine voltage regulation and efficiency.	K3
CO3	Identify the performance parameters of overhead lines and insulators.	K3
CO4	Explain the types and characteristics of underground cables.	K2
CO5	Choose the type of DC and AC distributors and solve for its performance parameters	K3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M				L				L	L	H	L
CO2	H	H	M								L	L	H	L
CO3	H	H	M				L						H	
CO4	H	M	L								L		H	
CO5	H	H	M								L	L	H	L

COURSE CONTENT:		
UNIT I	**TRANSMISSION LINE PARAMETERS**	**9**
Parameters of single and three phase transmission lines with single and double circuits - Resistance, inductance and capacitance of solid, stranded and bundled conductors, Symmetrical and unsymmetrical spacing and transposition - application of self and mutual GMD; skin and proximity effects - interference with neighbouring communication circuits.		
UNIT II	**MODELLING AND PERFORMANCE OF TRANSMISSION LINES**	**9**
Classification of lines - short line, medium line and long line - equivalent circuits, phasor diagram, attenuation constant, phase constant, surge impedance; transmission efficiency and voltage regulation, real and reactive power flow in lines- surge impedance loading- Ferranti effect.		
UNIT III	**INSULATORS & MECHANICAL DESIGN OF LINES**	**9**
Mechanical design of Overhead lines – Line supports – Overhead line insulators – Classification - Voltage distribution in suspension insulators - string efficiency – Stress and sag calculation – effects of wind and ice - Formation of Corona - critical voltages - losses - effect on line performance.		
UNIT IV	**UNDERGROUND CABLES**	**9**
Comparison between overhead line and underground cable – Constructional features - Types of cables - insulation resistance - potential gradient - capacitance of single core and three core cables - grading of cables - Types of grading of cables.		
UNIT V	**DISTRIBUTORS**	**9**
DC Distributors: Concentrated and distributed loads - Two wire distributor- radial distributor - fed at one end - fed at both ends - Ring main feeder - Advantages - Three wire distributor. AC Distributors: Concentrated loads with power factor refers to load point - refer to common load - three phase three wire and three phase four wire distributors.		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. Wadhwa,C.L., 'Electrical power systems', New age International Pvt Ltd. publishers,1995. 2. Gupta B.R., 'Power system Analysis & Design', Wheeler Publishing, 2006.		
REFERENCE BOOKS:		
1. Cotton H., 'Transmission and distribution of electrical Energy', ELBS,1985. 2. A. Chakrabarti ,P. V. Gupta , Soni M, Text Book on 'Power System Engineering', Wheeler Publishing, 2009. 3. V.K. Mehta, Rohit Mehta, 'Principles of power system' Chand publications, 4th Edition.		
ONLINE RESOURCES:		
1. https://onlinecourses.nptel.ac.in/noc22_ee98/preview		

COURSE CODE: **1151EE109**	COURSE TITLE: **POWER ELECTRONICS**	L	T	P	C
		2	**2**	**0**	**3**

COURSE CATEGORY: Program Core

PREAMBLE : This course being a core of power and energy control, forms the basis for understanding the efficient conversion, control and conditioning of electric power from its' available input into the desired electrical output form by using electronic devices.

PREREQUISITE COURSES: Electronic Devices & Circuits, Circuit Analysis

RELATED COURSES: LED Lighting Technology, Solid State Drives

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Get an overview of different types of power semi-conductor devices and their switching characteristics.
- Understand the operation, characteristics and performance parameters of controlled rectifiers.
- Study the operation, switching techniques and basic topologies of DC-DC switching regulators.
- Learn the different modulation techniques of stepped and pulse width modulated inverters and to understand the harmonic reduction methods.
- Know the practical applications of power electronics converters in conditioning the power supply.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's taxonomy)
CO1	Explain types of power semi-conductor devices and their switching characteristics.	K2
CO2	Compare the operation, characteristics and performance parameters of controlled rectifiers.	K2
CO3	Compare the operation, switching techniques and basic topologies of DC-DC switching regulators.	K2
CO4	Summarize techniques of pulse width modulated inverters and harmonic reduction methods.	K2
CO5	Identify practical and theoretical situations where AC voltage controller & Cycloconverter find their applications.	K3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	M		H							L	L	L
CO2	H	L	M		H							L	H	L
CO3	H	L	M		H								H	L
CO4	H	L	M		H								H	L
CO5	H	L	M		H							L	H	L

COURSE CONTENT:		
UNIT I	**POWER SEMI CONDUCTOR DEVICES**	**9**
Power switching devices overview: ideal & real switching characteristics - power diode, BJT, SCR, TRIAC, MOSFET, GTO, IGBT - VI characteristics, Turn-on, Turn-off methods; protection - di/dt, dv/dt, over current, over voltage, specifications, losses, thermal characteristics, series and parallel operation, triggering circuits.		
UNIT II	**CONTROLLED RECTIFIERS**	**9**
Operation and analysis of single and three phase rectifiers – half and fully controlled converters with R, RL and RLE loads with and without freewheeling diodes; converter and inverter operation – wave forms, gate time control, output voltage, input current, power factor, effect of load and source inductance. Commutation Techniques - Power factor and harmonic improvement methods – multi-phase width controlled, symmetrical angle controlled; series converter; dual converter modes – four-quadrant operation with and without circulating current modes; firing circuits.		
UNIT III	**CHOPPERS**	**9**
Principles of high power chopper circuits – voltage commutated, current commutated chopper, multi-phase chopper, multi-quadrant operation, switch mode regulators – principle of operation of buck, boost and buck boost regulators - time ratio control, variable frequency control, duty cycle.		
UNIT IV	**INVERTERS**	**9**
Principles of high power VSI and CSI inverters, Modified McMurray, auto sequential inverter,– waveforms at load and commutating elements, analysis of three phase inverter circuits with star and delta loads - control and modulation techniques - unipolar, bipolar inverters – voltage and frequency control - harmonics study.		
UNIT V	**AC CHOPPER AND CYCLOCONVERETERS**	**9**
Principle of single phase and three-phase AC voltage controller – ON/OFF and phase angle control - principle of single phase and three phase cyclo converters circuits, different control techniques and firing pulse generation – Applications - VVVF, UPS, Fan Regulator.		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. Muhammad H. Rashid, “Power Electronics: Circuits, Devices and Applications”, 3rd Edition, Pearson Education/Prentice Hall, 2004. 2. Singh, M.D. and Khanchandani, K.B., “Power Electronics”, 2nd Edition, Tata McGraw Hill, 2004.		
REFERENCE BOOKS:		
1. Bhimbra, P. S., “Power Electronics”, 4th Edition, Dhanpat Rai and Sons, 2000. 2. Bimal K. Bose, “Modern Power Electronics and AC Drives”, Pearson Education, 2003. 3. Ned Mohan, Tore M. Undeland, William P. Robbins, “Power Electronics Converters Applications and Design”, 3rd Edition, John Wiley and Sons, 2003.		
ONLINE RESOURCES:		
1. https://nptel.ac.in/courses/108101126		

COURSE CODE: **1151EE110**	COURSE TITLE: **POWER SYSTEM ANALYSIS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Core

PREAMBLE :

The course provides to the students with essential knowledge in power systems required for its analysis. It includes per-unit system, line models, application of network matrices techniques, power flow calculation for the steady-state and analysis, power system fault analysis including: symmetrical faults and unsymmetrical faults and power system stability.

PREREQUISITE COURSES:

Transmission & Distribution

RELATED COURSES:

Power system operation and control, Power system simulation Lab

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Introduce the characteristics of different transmission line models, steady state analysis and transient analysis of power systems
- Understand and performs the load flow analysis calculation for a power system network
- Analyse short circuit faults in power system.
- Provide the basic concept on power system stability

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's taxonomy)
CO1	Explain the fundamentals of power systems analysis and the modelling for power systems component	K2
CO2	Perform load flow analysis	K3
CO3	Identify symmetrical faults in power systems	K3
CO4	Analyze unsymmetrical faults in power systems	K3
CO5	Perform transient stability analysis of power systems	K3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	L	L								H	L
CO2	H	H	H	M	L						L	L	H	L
CO3	H	H	H	M	L		L				L	L	H	L
CO4	H	H	H	M	L		L				L	L	H	L
CO5	H	M	M	M								L	H	L

COURSE CONTENT:		
UNIT I	**THE POWER SYSTEM – AN OVERVIEW AND MODELLING**	**9**
Modern Power System - Basic Components of a power system - Per Phase Analysis Generator model - Transformer model - line model - The per unit system - Change of base.		
UNIT II	**POWER FLOW ANALYSIS**	**9**
Introduction - Bus Classification - Bus admittance matrix - Solution of non-linear Algebraic equations - Gauss seidal method - Newon raphson method - Fast decoupled method - Flow charts and comparison of the three methods.		
UNIT III	**FAULT ANALYSIS-BALANCED FAULT**	**9**
Introduction – Balanced three phase fault – short circuit capacity – systematic fault analysis using bus impedance matrix – algorithm for formation of the bus impedance matrix.		
UNIT IV	**FAULT ANALYSIS – SYMMETRICAL COMPONENTS AND UNBALANCED FAULT**	**9**
Introduction – Fundamentals of symmetrical components – sequence impedances – sequence networks – single line to ground fault – line fault - Double line to ground fault – Unbalanced fault analysis using bus impedance matrix.		
UNIT V	**POWER SYSTEM STABILITY**	**9**
Basic concepts and definitions – Rotor angle stability – Voltage stability – Mid Term and Long Term stability – Classification of stability – An elementary view of transient stability – Equal area criterion – Reponses to a short circuit fault- factors influencing transient stability – Numerical integration methods – Euler method – modified Euler method – Runge – Kutta methods.		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Hadi Saadat " Power system analysis", Tata McGraw Hill Publishing Company, New Delhi, 2002 (Unit I, II, III, IV)
2. P.Kundur, "Power System Stability and Control", Tata McGraw Hill Publishing Company, New Delhi, 1994 (Unit V)

REFERENCE BOOKS:

1. I.J.Nagrath and D.P.Kothari, 'Modern Power System Analysis', Tata McGraw-Hill publishing company, New Delhi, 1990.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/108105104

COURSE CODE: **1151EE111**	COURSE TITLE: **POWER SYSTEM OPERATION AND CONTROL**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Core

PREAMBLE: This course discussed about the preparatory work necessary for meeting the next day's operation and the various control actions to be implemented on the Power system network to meet the variations in load.

PREREQUISITE COURSES: Power System Analysis

RELATED COURSES: Protection and Switchgear

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Get an overview of real and reactive power operation and control
- Estimate the load demand and commit the generating units accordingly
- Create awareness on recent trends in power system operation and control

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's taxonomy)
CO1	Illustrate the importance of system frequency and voltage regulation in recent time	K2
CO2	Summarize methods in Forecasting of base load and Unit commitment	K2
CO3	Explain plant level and system level control of real power	K2
CO4	Solve Economic Dispatch problem including losses and lossless power system and Make use of controller for load frequency control	K3
CO5	Identify generation and absorption of Reactive power and methods of voltage control	K3

CORRELATION OF COs WITH POs AND PSOs

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L								L		L	H	L
CO2	H	M	M	L	L					L			H	L
CO3	H	M	M	L	M					L			H	L
CO4	H	M	M	L	M					L			H	L
CO5	H	L								L		L	H	L

COURSE CONTENT:

UNIT I	**INTRODUCTION**	**9**

Approach adopted in utilities for providing reliable, quality and economic electric power supply - Necessity for regulation of system frequency and voltage - P-F and Q-V control structure -

recent trends in real time control of power systems.

UNIT II	LOAD FORECASTING AND UNIT COMMITMENT	9

Load forecasting - components of system load - classification of base load - forecasting of the base load by method of least square fit - Introduction to unit commitment - constraints in unit commitment - unit commitment using priority list method and dynamic programming.

UNIT III	REAL POWER CONTROL	9

LOCAL CONTROL: Power control mechanism of individual machine - mathematical model of speed governing mechanism - speed load characteristics of governing mechanism - Regulation of two generators in parallel.

SYSTEM CONTROL: Division of power system into control areas - LFC control of a single area - static and dynamic analysis of uncontrolled system - proportional plus integral control of a single area - LFC control, of two area system - uncontrolled case - static and dynamic response - Tie line with frequency bias control of two area.

UNIT IV	ECONOMICS DISPATCH	9

Incremental cost curve - co-ordination equations with losses neglected - solution by iteration - co-ordination equations with loss included (No derivation of BMN co-efficient) - solution of co-ordination equations using BMN co-efficient by iteration method - Base point and participation factors - Economic dispatch controller added to LFC.

UNIT V	PRIORITY POWER CONTROL	9

LOCAL CONTROL: Fundamental characteristics of excitation system - Block diagram model of exciter system

SYSTEM CONTROL: Generation and absorption of reactive power - method of voltage control - injection of reactive power - static shunt capacitor/inductor VAR compensator - tap changing transformer.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Olle I. Elgerad, “Electric Energy System Theory and Introduction”, Tata Mc Graw Hill publishing company, New Delhi, 1983.
2. I.J.Nagrath, D.P.Kothari, "Power System Engineering", Tata Mc Graw Hill publishing company Ltd., 1998.
3. Allen J.Wood, Bruce F. Wollenbarg, “Power Generation, operation and control”, John Wiley and sons, 1984.

REFERENCE BOOKS:

1. B.M.Weedy, "Electric Power System", John Wiley & sons, Elsevier publishing company, Amsterdam, 1972.
2. A.K.Mahalanbias, D.P.Kothari & S.I.Ahson, "Computer Aided Power System Analysis and Control" Tata Mc Graw Hill publishing company, New Delhi, 1990.
3. Prabha Kundur “Power System Stability and Control”, McGraw-Hill Professional, 1994.

ONLINE RESOURCES: https://nptel.ac.in/courses/108105104

COURSE CODE: **1151EE112**	COURSE TITLE: **ELECTRICAL MACHINE DESIGN**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Core

PREAMBLE :

This course Electrical machine design provides an introduction to the design of various DC and AC Machines and gives a general idea to the computer aided design of Electrical machines.

PREREQUISITE COURSES:

DC Machines and Transformers, AC Machines

RELATED COURSES:

Special Electrical Machines

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Expose the students towards the design of various types of electrical machines
- Understand the basic concept of armature and field winding of DC machine
- Understand of basic design and cooling system of electrical transformer
- Understand the concept of induction machine
- Understand the concept of synchronous machine

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's taxonomy)
CO1	Exhibit the study of mmf calculation and thermal rating of various types of electrical machines.	K2
CO2	Explain armature and field systems for D.C machines.	K2
CO3	Demonstrate the design and cooling system of transformers.	K2
CO4	Construct the design of stator and rotor of induction machines.	K3
CO5	Choose appropriate design parameters of stator and rotor in synchronous machines.	K3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	M	L	L						L		M	M
CO2	H	H	H	M	L						L		H	M
CO3	H	H	H	M	L						L		H	M
CO4	H	H	H	M	L						L		H	M
CO5	H	H	H	M	L						L		H	M

COURSE CONTENT:		
UNIT I	**INTRODUCTION**	**9**
Standard specification for frame size - conductors and insulation of electrical apparatus - concept of magnetic circuit - MMF of electrical machines - Real and Apparent flux density - Gap contraction factor - Thermal rating of electrical apparatus – Performance prediction from thermal rating - heat flow, heating and cooling, temperature rise - turbo-alternator.		
UNIT II	**A.C MACHINES**	**9**
Constructional details of DC machine - Output equation - Choice of poles - Design of field system - Design of armature - Design of commutators and brush - Armature reactions.		
UNIT III	**TRANSFORMERS**	**9**
Constructional features - Output equation, output rating of single phase and three phase, optimum design - Design of core, design of winding - Calculation of circuit parameters - No load current – losses – efficiency, equivalent leakage reactance - per unit regulation - Design of tank and cooling tubes - Temperature rise.		
UNIT IV	**INDUCTION MACHINES**	**9**
Constructional details - Output equation - Choice of specific loadings - Design of squirrel cage rotor - Design of slip ring rotor - Design of end rings - Calculation of circuit parameters - No load current - Circle diagram.		
UNIT V	**DESIGN OF SYNCHRONOUS MACHINES**	**9**
Construction details - Runaway speed - Output equations - Choice of loading - Design of salient pole machine - Short circuit ratio - Armature design Armature parameters Estimation of air gap length - Design of damper winding - Determination of full load field MMF - Design of field winding - Introduction to computer aided design.		
		TOTAL: 45 PERIODS
TEXT BOOKS:		

1. Mittle V.M. and Mittl E.A, Design of Electrical Machines, standard publishers Distribution, Fourth edition, 1996.
2. Sawhney, A.K. A course in Electrical Machine Design, Dhanpat Rai & sons, 1993.

REFERENCE BOOKS:

1. Rai, H.M. Electrical Machine Design, Sathiya Prakashan Publications, Third edition, 1992.
2. Say M.G., The Performance & Design of Alternating current Machines Isaac Pitman & sons Ltd., London 1995.
3. Clayton, A.E., Performance & Design of Direct current Machines, English Language Book society & Sri Isaac Pitman & sons Ltd., London 1995

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/108105131
2. https://onlinecourses.nptel.ac.in/noc22_ee111/preview

COURSE CODE: **1151EE113**	COURSE TITLE: **MICROPROCESSOR AND MICROCONTROLLER**	L	T	P	C
		3	**2**	**0**	**4**

COURSE CATEGORY:

Program Core

PREAMBLE:

This course provides students with the knowledge of Microprocessors and Microcontroller. To solve real world problems in an efficient manner and this course also emphasis on architecture, Programming and system design used in various day to day gadgets.

PRE-REQUISITE COURSES:

Digital Electronics

RELATED COURSES:

Embedded System Design, Embedded Processors

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand the internal organization, addressing modes and instruction sets of 8085 processor.
- Familiar with the various functional units of 8051 microcontroller.
- Construct an embedded C and assembly language program by using 8051 Instruction sets and addressing modes.
- Understand the peripheral devices such as 8255, 8279, 8251, 8253, 8259 and 8237.
- Study the microcontroller based system design for various applications and advanced processors like PIC, ARM and ATMEGA.

COURSE OUTCOMES :

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

CO Nos.	**Course Outcomes**	**Knowledge Level (Based on revised Bloom's Taxonomy)**
CO1	Develop an ALP in 8085 microprocessor using the internal organization for the given specification	K3
CO2	Describe the architecture and functional block of 8051 microcontroller	K2
CO3	Develop an embedded C and ALP in 8051 microcontroller using the internal functional blocks for the given specification	K3
CO4	Explain the peripherals devices such as 8255, 8279, 8251, 8253, 8259 and 8237.	K2
CO5	Explain microcontroller applications and basic architecture of PIC, ARM and ATMEGA processors.	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	M	L	M						M	L	H	M
CO2	H	M	L										H	M
CO3	H	M	M	L	M						M	M	H	M
CO4	H	M	L									L	H	M
CO5	H	M	L	L								M	H	M

COURSE CONTENT:

UNIT I	**8085 CPU**	**9+3**

8085 Architecture – Pin diagram-Memory interfacing – I/O interfacing- Timing Diagram- Instruction Set- Addressing modes – Assembly language programming- comparison of 8 bit (8085) and 16 bit (8086) processors.

UNIT II	**8051 ARCHITECTURE**	**9+3**

Architecture – memory organization –I/O ports and circuits-Timers - Interrupts –serial communication - Interfacing of External memory-Interfacing LCD & Keyboard-RTC.

UNIT III	**8051 PROGRAMMING**	**9+3**

Addressing modes -instruction set -Assembly language programming and C Programming– Timer Counter Programming – Serial Communication Programming- Interrupt Programming.

UNIT IV	**PERIPHERAL DEVICES**	**10+3**

Parallel peripheral Interface (8255) - Timer / Counter (8253) - Keyboard and Display Controller (8279) - USART (8251) - Interrupt Controller (8259) - DMA Controller (8237).

UNIT V	**MICROCONTROLLER APPLICATIONS & ADVANCED PROCESSOR**	**8+3**

Temperature control system - Motor speed control system – Traffic light System – Elevator system - Data Acquisitions system - Introduction to architecture of PIC, ARM, ATMEGA processors.

TOTAL: 45+ 15(Tutorials) = 60 PERIODS

TEXT BOOKS:

1. Ramesh S Gaonkar, Microprocessor Architecture, Programming and application with 8085, 6th Edition, Penram International Publishing.
2. Muhammad Ali Mazidi , Janice Gillispie Mazidi and Rolin D McKinlay, The 8051 microcontroller and embedded systems using assembly and C, second edition Pearson education Asia.
3. Mohamed Rafiquzzaman, Microprocessor and Microcomputer based system design, second edition, CRC press.

REFERENCE BOOKS:

1. Kenneth J Ayala, The 8051 Microcontroller Architecture Programming and Application, third Edition, Penram International Publishers.
2. A.K Ray & K.M. Burchandi, Advanced Microprocessor and peripherals Architectures, Programming and interfacing “, second edition, Tata McGraw-Hill .

COURSE CODE: **1151EE114**	COURSE TITLE: **DISCRETE TIME SIGNAL PROCESSING**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Core

PREAMBLE: Digital Signal Processing provides an introduction to the basic concepts of signal processing methods and to acquire knowledge of analysis of systems using various transformation techniques. It provides students to realize about different filter structure and also to develop algorithm for signal processing.

PREREQUISITE COURSES: Transforms and Partial Differential Equations

RELATED COURSES:

Digital Control System

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Learn discrete Fourier transform and its properties
- Study the characteristics of IIR to design the IIR filter
- Design FIR Filter to filter the undesired signals
- Understand Finite word length effects & DSP Processor
- Study the concept of Multirate Signal processing & its Applications

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Apply Discrete Fourier Transform & Fast Fourier Transform for the given signals.	K3
CO2	Develop the Digital Infinite Impulse Response Filters (IIR) from given specifications	K3
CO3	Develop the Digital Infinite Impulse Response Filters (FIR) from given specifications	K3
CO4	Apply the basic signal processing concepts in DSP Processor and solve the finite word length effects on filters.	K3
CO5	Explain the basics of Multirate Signal Processing concepts & its applications.	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	M	H								H	
CO2	H	H	M	M	H								H	
CO3	H	H	M	M	H								H	
CO4	H	H	M	L	L								H	
CO5	H	H	M	L	L								H	

COURSE CONTENT:		
UNIT I	**DISCRETE FOURIER TRANSFORMS**	**9**
Introduction & Properties of DFT – Linear & Circular Convolution Methods, FFT algorithms – Radix-2 FFT algorithms – Decimation in Time – Decimation in Frequency algorithms –Use of FFT algorithms in Linear Filtering and correlation		
UNIT II	**IIR FILTER DESIGN**	**9**
Structures of IIR – Analog filter design – Discrete time IIR filter from analog filter – IIR filter design by using Impulse Invariance, Bilinear transformation - IIR Filter structures - Approximation of derivatives – (LPF, HPF, BPF, BRF) filter design using frequency translation.		
UNIT III	**FIR FILTER DESIGN**	**9**
Structures of FIR – Linear phase FIR filter - Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanning Window) - Frequency sampling techniques, FIR Filter structures.		
UNIT IV	**FINITE WORDLENGTH EFFECTS & DSP PROCESSOR**	**9**
Finite word length effects: Quantization- Truncation and Rounding errors - Quantization noise – coefficient quantization error – Product quantization error - Overflow error – limit cycle oscillations, scaling. Introduction to DSP architecture – Harvard architecture - Dedicated MAC unit - Multiple ALUs - Advanced addressing modes – Pipelining - Overview of instruction set of TMS320C5X and C54X.		
UNIT V	**MULTIRATE SIGNAL PROCESSING & APPLICATIONS**	**9**
Multirate signal processing: Decimation, Interpolation - Sampling rate conversion by a rational factor – Application - Sub band coding - Musical Sound Processing - Digital Audio sampling rate conversion - Oversampling A/D &D/A.		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. John G. Proakis & Dimitris G.Manolakis, “Digital Signal Processing – Principles, Algorithms & Applications”, 4th edition, Pearson Education / Prentice Hall, 2007. 2. B. Venkataramani, M. Bhaskar, “Digital Signal Processors: Architecture, Programming and Applications”, 2nd edition, Tata McGraw-Hill Education, 2002.		
REFERENCE BOOKS:		
1. S.Salivahanan, A.Vallavaraj, C Gnanapriya, “Discrete Signal Processing”, Tata McGraw-hill Publication, 2002. 2. Emmanuel C..Ifeachor, & Barrie.W.Jervis, “Digital Signal Processing”, 2nd edition, Pearson Education / Prentice Hall, 2002. 3. Sanjit K. Mitra, “Digital Signal Processing – A Computer Based Approach”, Tata Mc Graw Hill, 2007. 4. A.V.Oppenheim, R.W. Schafer and J.R. Buck, “Discrete-Time Signal Processing”, 8th Indian Reprint, Pearson, 2004.		
ONLINE RESOURCES:		
1. https://nptel.ac.in/courses/108106098		

COURSE CODE: **1151EE115**	COURSE TITLE: **LINEAR INTEGRATED CIRCUITS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Core

PREAMBLE: Linear Integrated Circuits introduces the basic concepts of Integrated circuits along with fundamental concepts of electronic circuits like operational amplifiers, rectifiers & timers.

PREREQUISITE COURSES:

Basic Electronics Engineering, Electronic Devices and Circuits

RELATED COURSES:

VLSI Design, Analog Communication Systems, Power System Operation and Control, Renewable Energy Sources.

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Familiar in the operational amplifier principle, analysis, design with its applications.
- Illustrate the linear and nonlinear applications of operational amplifiers.
- Understand the operating principles of PLL.
- Familiar in the operation of ADC, DAC and its classifications.
- Understand the applications of specific ICs.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Construct the electronic circuits using Operational Amplifier for the given specifications.	K3
CO2	Explain the linear and nonlinear applications of Operational Amplifier including comparators and waveform generators.	K2
CO3	Summarize the operating principle of PLL and its applications.	K2
CO4	Illustrate the construction, types and operation of ADC / DAC.	K2
CO5	Explain the applications of special function IC's such as voltage Regulators, 555 timer.	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	L	L								H	
CO2	H	M	M	M	L								H	
CO3	H	M	M	M	L								H	
CO4	H	M	M	M	L						L		H	
CO5	H	M	M		L						L	M	H	M

COURSE CONTENT:		
UNIT I	**INTRODUCTION TO OPERATIONAL AMPLIFIERS**	**12**
BJT differential amplifier - Concept of CMRR - methods to improve CMRR - constant current source - active load - current mirror - Darlington pair differential input impedance - The Ideal Op Amp - Block diagram representation of Op Amp Voltage Transfer Curve of Op Amp - DC and AC Characteristics of an Op Amp - Frequency Response - Slew Rate. Active Filters: Low pass, High Pass and band pass filters - Switched capacitor filter		
UNIT II	**APPLICATIONS OF OPERATIONAL AMPLIFIERS**	**9**
Linear Applications: Inverting and Non inverting Amplifiers – Differentiator – Integrator - Voltage to current converter - Instrumentation amplifier Non Linear Applications: Clippers and Clampers - Precision rectifier - Log and Antilog amplifiers Comparators and Wave form Generators: Comparator - Regenerative comparator – Astable Multivibrators – Monstable Multivibrators - Triangular wave generator - Sine wave generators.		
UNIT III	**PLL**	**6**
Voltage Controlled Oscillator- Closed loop analysis of PLL – PLL Applications - Frequency synthesizers.		
UNIT IV	**ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS**	**9**
Analog switches - High speed sample and hold circuits and sample and hold ICs - Types of D/A converter - Current driven DAC - Switches for DAC- A/D converter Flash - Single slope - Dual slope - Successive approximation - Delta Sigma Modulation - Voltage to Time converters.		
UNIT V	**SPECIAL FUNCTION ICs**	**9**
555 Timer: Astable and Monostable Multivibrators, Schmitt trigger Voltage regulators using op-amp - linear and switched mode types - Frequency to Voltage converters - Tuned amplifiers - Video amplifiers - ECG using op-amp.		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. D. Roy Choudhry and Shail B. Jain, "Linear Integrated Circuits"- (d/e), New Age International Pvt. Ltd, 2011. 2. 2. R. Gayakwad, Op-amps and Linear Integrated Circuits (d/e), PHID. A. Bell, Solid state Pulse Circuits (d/e), PHI, 2009.		
REFERENCE BOOKS:		
1. S. Franco, Design with Operational Amplifiers and Analog Integrated Circuits (c/e) TMH, 2003. 2. R. F. Coughlin & F. F. Driscoll: Operational Amplifiers and Linear Integrated circuits, PHI, 1996. 3. D. A. Bell: Solid State pulse circuits, (d/e), PHI. Milman Gravel: Micro-Electronics, McGraw Hill, 1999.		
ONLINE RESOURCES:		
1. https://nptel.ac.in/courses/108105158		

COURSE CODE: **1151EE116**	COURSE TITLE: **NUMERICAL METHODS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Core

PREAMBLE : This course provides an introduction to the basic concepts and techniques of numerical solution of algebraic equation, system of algebraic equation, numerical solution of differentiation, integration methods.

PREREQUISITE COURSES: Engineering Mathematics-I

RELATED COURSES: Power system Analysis, power system operation & control and allied subjects related numerical interpolation and transcendental equation.

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Develop the mathematical skills of the students in the areas of numerical methods.
- To teach theory and applications of numerical methods in a large number of engineering subjects which require solutions of linear systems, finding eigen values, eigenvectors, interpolation and applications, solving ODEs, PDEs.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's taxonomy)
CO1	Apply numerical methods to find our solution of algebraic equations using different methods under different conditions, and numerical solution of system of algebraic equations.	K3
CO2	Apply various interpolation methods and finite difference concepts.	K3
CO3	Solve numerical differentiation and integration whenever and wherever routine methods are not applicable.	K3
CO4	Solve on the ordinary differential equations using different methods through the theory of finite differences.	K3
CO5	Solve numerically on the partial differential equations using different methods through the theory of finite differences.	K3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L								L		L	H	L
CO2	H	M	M	L	L					L			H	L
CO3	H	M	M	L	M					L			H	L
CO4	H	M	M	L	M					L			H	L
CO5	H	L								L		L	H	L

COURSE CONTENT:		
UNIT I	**SOLUTION OF TRANSCENDENTAL EQUATIONS AND EIGENVALUE PROBLEMS**	**9**
Solution of equations – iteration method – Newton-Raphson Method – solution of linear system by Gaussian elimination and Gauss-Jordan method – iterative methods – Gauss-Jacobi and Gauss-Seidel methods – inverse of a matrix by Gauss-Jordon method –finding the eigenvalues of a matrix by power method		
UNIT II	**INTERPOLATION**	**9**
Lagrangian interpolating polynomials – interpolation with equal intervals – Newton's forward and backward difference formulae – central difference formulae – interpolation with unequal intervals – divided differences – Newton's divided difference formula.		
UNIT III	**NUMERICAL DIFFERENTIATION AND INTEGRATION**	**9**
Differentiation using interpolation formulae – numerical integration by trapezoidal and Simpson's 1/3 and 3/8 rules – Romberg's method – two and three point Gaussian quadrature formulae – double integrals using trapezoidal and Simpson's rules.		
UNIT IV	**NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**	**9**
Single-step methods – Taylor series method – Euler method for first order equation – Fourth order Runge-Kutta method for solving first and second order equations – multi-step methods – Milne's and Adam's predictor and corrector methods		
UNIT V	**NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS**	**9**
Classification of second order PDE - finite-difference approximations to partial derivatives – solution of Laplace and Poisson equations – solution of one-dimensional heat equation – solution of two-dimensional heat equation - solution of wave equation		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. S.S. Sastry, Introductory Methods of Numerical Analysis, 4th edition, PHI Learning Private Limited, New Delhi, 2007. 2. B.S. Grewal and J.S. Grewal, Numerical Methods in Engineering and Science, 6th edition, Khanna Publishers, New Delhi, 2004. 3. John H. Mathews and Kurtis D. Fink, Numerical Methods using MATLAB, 4th edition, PHI Learning Private Limited, New Delhi, 2007. 4. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, 6th edition, Pearson Education, Asia, New Delhi, 2006.		
REFERENCE BOOKS:		
1. A.K. Ray and K.M.Burchandi, Intel Microprocessors Architecture Programming and Interfacing, McGraw Hill International Edition, 2000 2. Kenneth J Ayala, The 8051 Microcontroller Architecture Programming and Application, 2nd Edition, Penram International Publishers (India), New Delhi, 1996.		
ONLINE RESOURCES: https://nptel.ac.in/courses/111107107		

INTEGRATED COURSE

COURSE CODE: **1151EE201**	COURSE TITLE: **ELECTROMAGNETIC FIELDS**	L	T	P	C
		2	**0**	**2**	**3**

COURSE CATEGORY: Program Core

PREAMBLE : The purpose of this course is to provide students with an introduction to the fundamentals of electrostatics, magneto statics, and electromagnetic waves.

PREREQUISITE COURSES: Engineering Physics

RELATED COURSES: AC Machines, Special Electrical Machines

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand the fundamental nature of static electric fields, potential, flux, charge densities, static magnetic fields, stored energy and boundary conditions.
- Impart Knowledge on the Basic laws that are governing the electromagnetic fields.
- Introduce the concepts of electromagnetic waves and its sources

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain about electrostatics and sources of electric fields	K2
CO2	Apply the knowledge of electrostatics for dielectric study	K3
CO3	Explain about magnetostatics and sources of magnetic fields	K2
CO4	Make use of Finite Element Method to solve field Equations	K3
CO5	Explain about Electromagnetic waves in in free space, lossy and lossless dielectrics and their importance	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	L		M								H	
CO2	H	H	L		M								H	
CO3	H	H	L		M								H	
CO4	H	H	L										H	
CO5	H	H	L										H	

COURSE CONTENT:

UNIT I	**ELECTROSTATICS-I**	**9**

Sources and effects of electromagnetic fields – Coordinate Systems – Vector fields –Gradient, Divergence, Curl – theorems and applications - Coulomb's Law – Electric field intensity – Field due to discrete and continuous charges – Gauss's law and applications.

UNIT II	ELECTROSTATICS-II	9
Electric potential – Electric field and equipotential plots, Uniform and Non-Uniform field, Utilization factor – Electric field in free space, conductors, dielectrics - Dielectric polarization – Dielectric strength - Electric field in multiple dielectrics – Boundary conditions, Poisson's and Laplace's equations - Applications.		
UNIT III	**MAGNETOSTATICS**	**9**
Lorentz force, 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) – B in free space, conductor - magnetic materials – Magnetization, Magnetic field in multiple media – Boundary conditions - Poisson's Equation - Applications		
UNIT IV	**ELECTRODYNAMIC FIELDS AND SOLUTION OF FIELD EQUATIONS (FEM)**	**9**
Magnetic Circuits - Faraday's law – Transformer and motional EMF – Displacement current - Maxwell's equations (differential and integral form) – Relation between field theory and circuit theory – Applications.		
UNIT V	**ELECTROMAGNETIC WAVES**	**9**
Electromagnetic wave generation and equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossy and lossless dielectrics, conductors - skin depth - Poynting vector, Application		
		TOTAL: 60 PERIODS

EXPERIMENTS:

1. Analyzing flux distribution in core and shell type transformers
2. Analyzing flux distribution of motor
3. Analyzing current distribution of generator
4. Coulombs law with two charged objects
5. Electromagnetic induction and charged particle in magnetic field

TEXT BOOKS:

1. Mathew N. O. Sadiku, 'Principles of Electromagnetics', 4 th Edition, Oxford University Press In3.First India edition, 2009.
2. Ashutosh Pramanik, 'Electromagnetism – Theory and Applications', PHI Learning Private Limited, New Delhi, Second Edition-2009.
3. K.A. Gangadhar, P.M. Ramanathan ' Electromagnetic Field Theory (including Antennas and wave propagation', 16th Edition, Khanna Publications, 2007.

REFERENCE BOOKS:

1. Joseph. A.Edminister, 'Schaum's Outline of Electromagnetics, Third Edition (Schaum's Outline Series), Tata McGraw Hill, 2010
2. William H. Hayt and John 1. Buck, 'Engineering Electromagnetics', Tata McGraw Hill 8th Revised edition, 2011.
3. Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill International Editions, Fifth Edition, 2010.
4. D. K. Cheng, Field and Wave Electromagnetics, Addison-Wesley, 1992

LABORATORY COURSES

COURSE CODE: **1151EE301**	COURSE TITLE: **CIRCUIT ANALYSIS LAB**	L	T	P	C
		0	**0**	**2**	**1**

COURSE CATEGORY: Program Core

PREAMBLE:

This course aims to make the students verify network laws and theorems practically and also helps to understand circuits with three phase, resonance and transients

PREREQUISITE COURSES:

Basic Electrical & Electronics Engineering Lab

RELATED COURSES:

Control Systems Lab

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Provide the verification of basic network laws and theorems
- Analyze circuits involving three phase, resonance and transients.
- Understand the importance of two port network parameters.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Execute basic circuit laws and network theorems	K3, S2
CO2	Build the two port networks	K3, S2
CO3	Demonstrate the use of CRO/DSO for measurement	K3, S3
CO4	Perform power measurement in electrical system	K3, S2
CO5	Demonstrate the time and frequency response of RLC circuits	K3, S3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	M	L				M	L		L	M	H
CO2	H	H	M	M	L				M	L		L	M	H
CO3	H	H	M	M	L				M	L		L	M	H
CO4	H	H	M	M	L				M	L		L	M	H
CO5	H	H	M	M	L				M	L		L	M	H

LIST OF EXPERIMENTS:

1. Verification of Kirchhoff's voltage and Current Laws.
2. Verification of Network theorems(Superposition, Thevenin's and Maximum power transfer theorems)
3. Measurement of frequency and phase difference using CRO/DSO.

4. Frequency response of series RLC circuit.
5. Measurement of form factor and peak factor for different waveforms.
6. Measurement of two port network parameters.
7. Power and power factor measurement by two wattmeter method.
8. Measurement of Energy using single phase energy meter.
9. Transient response of series RL and RC circuit.
10. Simulation of low pass and high pass passive filters.

COURSE CODE: **1151EE302**	COURSE TITLE: **ELECTRONIC DEVICES & CIRCUITS LAB**	L	T	P	C
		0	**0**	**2**	**1**

COURSE CATEGORY:

Program Core

PREAMBLE :

It is aimed to gain knowledge on electronic devices and circuits operation for various applications.

PREREQUISITE COURSES:

Basic Electrical & Electronics Engineering Lab

RELATED COURSES:

Power Electronics and Drives Lab

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand the characteristics of various electronic devices.
- Understand the performance characteristics of amplifiers.
- Gain the knowledge about frequency response analysis of amplifier circuits.
- Understand the design aspects of oscillator circuits.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Perform chrateristics of transistor, MOSFET,JFET, SCR and UJT	K3, S2
CO2	Demonstrate the performance characteristics of amplifier circuits	K3, S3
CO3	Build the circuit for voltage regulation for the given specification	K3, S2
CO4	Demonstrate the performance characteristics of clipper and clamper circuits	K3, S3
CO5	Demonstrate the operation of RC phase shift oscillator and Wein Bridge Oscillator circuits	K3, S3

CORRELATION OF COs WITH POs AND PSOs

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L			L				M	L		L	L	L
CO2	H	M	M	M	L	L			M	L	L	L	M	M
CO3	H	L			L				M	L		L	M	M
CO4	H	L			L	L			M	L		L	M	M
CO5	H	M	M	M	L	L			M	L	L	L	M	M

COURSE CONTENT:

LIST OF EXPERIMENTS:

1. Bipolar Junction transistor - CE, CB, CC characteristics
2. JFET – characteristics and parameter determination
3. UJT & SCR Characteristics & UJT – Controlled SCR
4. Characteristics of BJT Amplifier frequency response
5. Characteristics of Class A & B amplifier
6. Characteristics of Class C & D amplifier
7. Positive and negative Clipper circuits design and Characteristic
8. Positive and negative clamper circuits design and Characteristic
9. Voltage regulators (load and line regulation).
10. RC phase shift oscillator circuit design and verification
11. Wien Bridge oscillator circuit design and verification

COURSE CODE: **1151EE303**	COURSE TITLE: **DC MACHINES & TRANSFORMERS LAB**	L	T	P	C
		0	**0**	**2**	**1**

COURSE CATEGORY:

Program Core

PREAMBLE :

The course provides an introduction to DC machines and transformers. It deals with load and open circuit characteristics DC machines and transformers.

PREREQUISITE COURSES:

Basic Electrical & Electronics Engineering Lab

RELATED COURSES:

Solid State Drives, AC Machines, Control System, Special Electrical Machines

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Expose the student for the operation of DC machines and transformers and provide experimental skills

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Perform the characteristic study of DC Shunt Generator	K3, S3
CO2	Perform the characteristic study of DC compound machines	K3, S3
CO3	Perform the load characteristic of DC motors.	K3, S3
CO4	Demonstrate speed control methods for DC motors and also perform the Swinburne's test to find the efficiency of DC machines	K3, S3
CO5	Execute testing methods for calculating performance parameters of Transformers	K3, S2

CORRELATION OF COs WITH POs AND PSOs

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H		M					M	L		L	H	M
CO2	H	H		M	L				M	L			H	M
CO3	H	H		M	L				M	L			H	M
CO4	H	H		M	L				M	L		L	H	M
CO5	H	H		M					M	L			H	M

COURSE CONTENT:

LIST OF EXPERIMENTS

1. Open circuit and load characteristics of D.C separately excited shunt generator
2. Open circuit and load characteristics of D.C self-excited shunt generator
3. Load characteristics of D.C. compound generator with differential and cumulative connection
4. Load characteristics of DC compound motor
5. Load characteristics of D.C shunt motor
6. Load characteristics of D.C series motor
7. Swinburne's test in DC machine
8. Speed control of D.C shunt motor
9. Open circuit and short circuit tests on single and three phase transformer
10. Load test on single and three phase transformer
11. Separation of no-load losses in single phase transformer

COURSE CODE: **1151EE304**	COURSE TITLE: **AC MACHINES LAB**	L	T	P	C
		0	**0**	**2**	**1**

COURSE CATEGORY:

Program Core

PREAMBLE:

The course provides the information to obtain the various performance characteristics of Three phase induction motors, single phase induction motors and synchronous machines by conducting different test methods. It also gives the information on speed control of slip ring induction motor.

PREREQUISITE COURSES:

DC Machines and Transformer

RELATED COURSES:

Solid State Drives, Special Electrical Machines

COURSE EDUCATIONAL OBJECTIVES:

The objective of the course is to,

- Understand the various performance characteristics of Induction motors and Synchronous machines.

COURSE OUTCOMES:

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's taxonomy)
CO1	Perform OC and SC tests on three phase Alternator to determine regulation using EMF, MMF, ZPF and slip test methods.	K3, S2
. CO2	Execute load test on Synchronous motor for identifying V and inverted V curves	K3, S2
CO3	Perform OC and SC tests on three phase Induction motor for identifying performance characteristics through circle diagram	K3, S2
CO4	Build the equivalent circuit parameters of Induction motors using No load test and Blocked rotor test	K3, S2
CO5	Execute speed control in slip ring induction motor	K3, S2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H		M					M	L			H	L
CO2	H	H		M					M	L			H	L
CO3	H	H		M					M	L			H	L
CO4	H	H		M					M	L			H	L
CO5	H	H		M	L				M	L			H	L

COURSE CONTENT:

LIST OF EXPERIMENTS

1. Determination of voltage Regulation of three phase alternator by EMF and MMF methods
2. Determination of voltage Regulation of three phase alternator by ZPF method
3. Slip test on three phase alternators.
4. V and Inverted V curves of Three Phase Synchronous Motor
5. Load test on three-phase induction motor
6. No load and blocked rotor test on three-phase induction motor.
7. Separation of No-load losses of three-phase induction motor
8. Load test on single-phase induction motor
9. No load and blocked rotor test on single-phase induction motor
10. Study of different Speed control of three phase Slip ring Induction motor

COURSE CODE: **1151EE305**	COURSE TITLE: **CONTROL & INSTRUMENTATION LAB**	L	T	P	C
		0	**0**	**2**	**1**

COURSE CATEGORY:

Program Core

PREAMBLE :

The aim of this lab is to fortify the students with an adequate work experience in the measurement of different quantities and also the expertise in Digital simulation of systems

PREREQUISITE COURSES:

Circuit Analysis Lab

RELATED COURSES:

DC Machines & Transformers Lab

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Done the Measurement of displacement, resistance, inductance, torque and angle
- Give exposure to AC, DC bridges measurement.
- Design the compensators
- Determine the transfer function of Electrical Machines

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Demonstrate the transfer function of Electrical Machines	K3, S3
CO2	Execute the design of first and second order and compensators	K3, S2
CO3	Perform measurement of phase difference, voltage, current and frequency of an input signal	K3, S2
CO4	Perform the measurement of circuit parameters using DC and AC bridges	K3, S2
CO5	Perform the measurement of BH curve using solenoid	K3, S2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	M	M				M	L	L	L	H	M
CO2	H	H	M	M	M				M	L	L	L	H	M
CO3	H	H		M	L				M	L		L	H	M
CO4	H	H	M	M	L				M	L		L	H	M
CO5	H	H		M	L				M	L		L	H	M

COURSE CONTENT:

LIST OF EXPERIMENTS

1. Measurement of phase difference and frequency of a sinusoidal ac voltage using C.R.O.
2. Measurement of voltage, current and resistance using dc potentiometer

3. Measurement of low resistance by Kelvin's double bridge
4. Measurement of inductance through various bridges (Maxwell's bridge, Hay's bridge, Anderson's bridge)
5. Measurement of capacitance through various bridges (Owen's bridge, De Sauty bridge, Schering bridge)
6. Determination of BH curve using solenoid
7. Determination of transfer function of DC machines
8. Determination of transfer function of servo motors
9. Digital simulation of first and second order systems using time and frequency response methods and obtaining the performance specifications
10. Design of compensator (lead,lag, lag-lead) of a system by digital simulation

COURSE CODE: **1151EE306**	COURSE TITLE: **MICROPROCESSOR & MICROCONTROLLER LAB**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

COURSE CATEGORY:

Program Core

PREAMBLE :

Microprocessors and Microcontrollers laboratory course helps the students to develop their knowledge on processor architecture and the programming skills. This laboratory course provides hands-on experience to interface I/O devices. The skills acquired through the experiments help the students do their projects and enhance their knowledge on the latest trends and technologies.

PREREQUISITE COURSES: Electronic Devices & Circuits Lab

RELATED COURSES: Project Work

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Give hands on experience in 8085 assembly language programming.
- Give hands on experience in peripheral interfacing with 8085 and 8051.
- Introduce 8051 microcontroller programming.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's taxonomy)
CO1	Demonstrate an assembly language programs for all arithmetic operations and code conversions using instruction sets of 8085.	K3, S3
CO2	Perform an assembly language program for interfacing 8085 with USART, ADC/DAC, Timer IC & Keyboard / Display Controller).	K2, S2
CO3	Demonstrate an assembly language programs for all arithmetic operations, Timers/Counters and Interrupt handling using instruction sets of 8051.	K3, S3
CO4	Perform an assembly language program for interfacing 8051 with Stepper Motor, DC Motor, ADC/DAC, Matrix/Keyboard & LCD.	K2, S2
CO5	Demonstrate an assembly language programs for all arithmetic operations and code conversions using instruction sets of ARM processor.	K3, S3

CORRELATION OF COs WITH POs AND PSOs

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	M	M	M				M	L	L	L	H	M
CO2	H	M	M	M	M				M	L	L	L	H	M
CO3	H	M		M	L				M	L		L	H	M
CO4	H	M	M	M	L				M	L		L	H	M
CO5	M	M		M	L				M	L		L	H	M

COURSE CONTENT:

LIST OF EXPERIMENTS

Assembly Language Programming With 8085:

1. Arithmetic Operations of two 8-bit numbers (Addition, Subtraction, Multiplication & Division).
2. Arranging an array of data (ascending order & descending order).
3. Code Conversion (BCD to HEX, HEX to BCD, HEX to ASCII & ASCII to HEX).
4. Interfacing (8251 (USART), ADC/DAC, 8253 (Timer IC) & 8279 (Keyboard/Display Controller).

Assembly Language Programming With 8051 Microcontroller:

5. Arithmetic Operations of two 8-bit numbers (Addition, Subtraction, Multiplication & Division).
6. Verify Timer/ Counter.
7. Verify Interrupt Handling.
8. Interfacing (Stepper Motor, DC Motor, ADC/DAC, Matrix/Keyboard & LCD).

Assembly Language Programming with ARM Processor:

9. Arithmetic Operations of two 8-bit numbers (Addition, Subtraction, Multiplication & Division).
10. Code Conversion.

COURSE CODE: **1151EE307**	COURSE TITLE: **DISCRETE TIME SIGNAL PROCESSING LAB**	L	T	P	C
		0	**0**	**2**	**1**

COURSE CATEGORY:

Program Core

PREAMBLE :

To carry out software and hardware experiments illustrating the basic principles and techniques of digital signal processing and to learn the programming of real-time signal processing algorithms on a concrete DSP chip.

PREREQUISITE COURSES:

Transform and Partial Differential Equations

RELATED COURSES:

Embedded System

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to

- Understand the architecture of DSP processor
- Learn the implementation aspects of FFT
- Understand the Linear and Circular Convolution
- Understand the design concepts of FIR and IIR filters

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Demonstrate the applications of Fast Fourier Transform	K3, S3
CO2	Execute Linear and Circular Convolution	K3, S2
CO3	Perform IIR and FIR filters	K3, S2
CO4	Perform sampling and aliasing on the given signal	K3, S2
CO5	Demonstrate DSP processor based implementation of filters	K3, S3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	M	M				M	L		L	M	H
CO2	H	H	M	M	M				M	L		L	M	H
CO3	H	H	M	M	M				M	L		L	M	H
CO4	H	H	M	M	M				M	L		L	M	H
CO5	H	H	M	M	M				M	L		L	M	H

COURSE CONTENT:

LIST OF EXPERIMENTS

MATLAB / Equivalent Software Package

1. Generation of different types of signals
2. Implementation of Linear and Circular Convolutions
3. Implementation of Fast Fourier Transform
4. Design FIR filter
5. Design IIR filter
6. Sampling & Aliasing

DSP Processor Based Implementation

7. Study the architecture and addressing modes of Digital Signal Processor
8. Implementation of Linear Convolution
9. Implementation of Circular Convolution
10. FIR Filter Implementation
11. IIR Filter Implementation
12. Sampling of Input Signals

COURSE CODE: **1151EE308**	COURSE TITLE: **POWER ELECTRONICS & DRIVES LAB**	L	T	P	C
		0	**0**	**2**	**1**

COURSE CATEGORY:

Program Core

PREAMBLE :

This lab introduces the concept of power control and power conversion techniques and helps to control DC motors and Induction motors.

PREREQUISITE COURSES:

Electronic Devices & Circuits Lab

RELATED COURSES:

Power System Simulation lab

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Make the students aware of different power conversion techniques.
- Understand the various control methods for machines

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Sketch the characteristics of various power switching devices.	K2,S2
CO2	Demonstrate the concept of working of single phase and three phase rectifiers.	K3,S3
CO3	Show the working of power circuit and control circuit of single phase half & full bridge inverters and three phase inverters.	K3,S3
CO4	Accomplish the task of implementing a DC-DC converters with control.	K3,S3
CO5	Demonstrate the working of phase controlled AC-AC converters i.e controllers and cycloconverters.	K3,S3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		M	M							M	M		
CO2	H		H	H		M					H	H	M	
CO3	M		M	M		M					M	M		
CO4	M	M		M		M			M		M	M		M
CO5	H	H	H	H		M			H		H	H		

COURSE CONTENT:

LIST OF EXPERIMENTS

1. VI Characteristics of SCR, IGBT &MOSFET.
2. Single phase full converter feeding R, RL, RLE load.
3. Single phase semi converter feeding R, RL, RLE load.
4. Single phase dual converter.
5. MOSFET based step up and step down chopper
6. IGBT based single phase PWM inverter.
7. Three phase IGBT based PWM inverter control of induction motor.
8. Single phase AC voltage controller
9. Single phase cycloconverter
10. Three phase full converter.
11. Series resonant converter.

COURSE CODE: **1151EE309**	COURSE TITLE: **POWER SYSTEM SIMULATION LAB**	L	T	P	C
		0	**0**	**2**	**1**

COURSE CATEGORY:

Program Core

PREAMBLE :

This course teaches Modelling of Transmission Lines, and Solution of Load Flow analysis

PREREQUISITE COURSES:

Circuit Analysis Lab

RELATED COURSES:

Power System Operation and Control

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand about transmission line parameters.
- Formulate Z bus and Y bus
- Develop Load flow analysis – GS and NR method
- Construct suitable model for load frequency control
- Perform Short circuit analysis for the given power system network
- Solve transient stability problem for the power system
- Plan economic dispatch schedule for the given power system

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Perform the calculation for transmission line parameters	K2,S2
CO2	Build Z bus and Y bus and perform load flow analysis	K2,S2
CO3	Perform Short circuit analysis	K3,S3
CO4	Demonstrate load frequency control on power system	K2,S2
CO5	Execute transient stability study	K2,S2
CO6	Perform Economic dispatch schedule	K2,S2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	L	H				L	L	L	L	H	M
CO2	H	H	M	L	H				L	L	L	L	H	M
CO3	H	H	M	L	H	L			L	L	L	L	H	M
CO4	H	H	M	L	H	L			L	L	L	L	H	M
CO5	H	H	M	L	H	L			L	L	L		H	M
CO6	H	H	M	L	H				L	L	L		H	M

COURSE CONTENT:

LIST OF EXPERIMENTS

1. Calculation of transmission line parameters using MATLAB
2. Voltage regulation and efficiency calculation of medium, long transmission line using MATLAB
3. Formulation of Y bus and Z bus matrix using MATLAB
4. Load flow analysis – GS method using MATLAB
5. Load flow analysis – NR method using MATLAB
6. Short circuit analysis on DC network analyzer
7. Symmetrical component analyzer
8. Transient stability analysis
9. Load frequency control of single area and two area power system with MATLAB/Simulink
10. Economic dispatch control using MATLAB

PROGRAMME ELECTIVE COURSES

COURSE CODE: **1152EE101**	COURSE TITLE: **POWER QUALITY ENGINEERING**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Elective

PREAMBLE :

This course covers an introduction to power quality, voltage sags, overvoltage, harmonics and power quality montoring

PREREQUISITE COURSES: Power System Analysis

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand about basics of power system quality
- Acquire knowledge in calculation of voltage sags and interruptions
- Familiar with overvoltage and its causes
- Explain about harmonic distortion and its control
- Understand the power quality monitoring and its equipments

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain about power system quality issues	K2
CO2	Calculate voltage sags and interruptions	K2
CO3	Have an insight on over voltages and its causes	K2
CO4	Explain about harmonic distortion and its control	K2
CO5	Illustrate the fundamentals of power quality monitoring and its equipments	K2

CORRELATION OF COs AND POs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L								L	M	H	L
CO2	H	M	L								L	M	H	L
CO3	H	M	L								L	M	H	L
CO4	H	M	L								L	M	H	L
CO5	H	M	L								L	M	H	L

COURSE CONTENT:		
UNIT I	**INTRODUCTION TO POWER QUALITY**	**9**
Terms and definitions – Overloading – Under voltage – Sustained interruption-Sags and Swells – Waveform distortion – Total Harmonic Distortion (THD) – Computer Business Equipment Manufacturers Associations (CBEMA) curve		
UNIT II	**VOLTAGE SAGS AND INTERRUPTIONS**	**9**
Sources of sags and interruptions – Estimating voltage sag performance – Motor starting sags – Estimating the sag severity – Mitigation of voltage sags – Active series compensators – Static transfer switches and fast transfer switches		
UNIT III	**OVERVOLTAGES**	**9**
Sources of over voltages – Capacitor switching – Lightning – Ferro resonance – Mitigation of voltage swells – Surge arresters – Low pass filters – Power conditioners – Lightning protection – Shielding – Line arresters – Protection of transformers and cables – Computer analysis tools for transients – PSCAD and EMTP		
UNIT IV	**HARMONICS**	**9**
Harmonic distortion – Voltage and current distortion – Harmonic indices – Harmonic sources from commercial and industrial loads – Locating harmonic sources – Power system response characteristics – Resonance – Harmonic distortion evaluation – Devices for controlling harmonic distortion – Passive filters – Active filters – IEEE and IEC standards		
UNIT V	**POWER QUALITY MONITORING**	**9**
Monitoring considerations – Power line disturbance analyzer – Power quality measurement equipment – Harmonic / spectrum analyzer – Flicker meters – Disturbance analyzer – Applications of expert system for power quality monitoring		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. Math H.J.Bollen, Understanding Power Quality Problems-Voltage sag & Interruptions, IEEE Press,2000 2. Roger C. Dugan, Mark F. McGranagham, Surya Santoso and H.Wayne Beaty, “Electrical Power Systems Quality”, McGraw Hill, 2003.		
REFERENCE BOOKS:		
1. PSCAD User Manual. 2. Power Quality in Electrical Systems - Alexander Kusko ,McGraw-Hill		
ONLINE RESOURCES:		
1. https://nptel.ac.in/courses/108102179		

COURSE CODE: **1152EE102**	COURSE TITLE: **PROTECTION AND SWITCH GEAR**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Elective

PREAMBLE : The functioning of a power system depends significantly on efficient and reliable protection schemes. This course covers a refreshed pedagogy of Power System Protection and Switchgear technology covering the contemporary protection system, relay & breaker principles, Types operations and applications infused with measuring, control and regulating arrangements for modern power system network.

PREREQUISITE COURSES:

- Circuit Analysis, DC Machines and Transformer

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand the essential qualities of a reliable protective system and protection terminologies
- Explain the operating principles of various relays based upon technology and functional requirements
- Understand Protection of electrical power apparatus generation, transmission and distribution system
- Understand the arcing phenomena, arc quenching and breaking in circuit breakers
- Classify different circuit breaker principles and operation

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	List out essential qualities of a protective system and protection terminologies.	K2
CO2	Contrast operating principles of relays based on technology and functional requirements.	K2
CO3	Summarize protection schemes for generation, transmission and distribution system	K2
CO4	Interpret about the arcing phenomena, arc quenching in circuit breakers.	K2
CO5	Compare different Circuit breaker principles and operation	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1
CO1	H	L											H
CO2	H				L	L	L					L	H
CO3	H	L	L		L	L	L					L	H
CO4	H	L	L										H
CO5	H					L	L					L	H

COURSE CONTENT:		
UNIT I	**INTRODUCTION**	**9**
Basic ideas of short circuit currents and relay protection - basic terminology - essential qualities of a protective relay - operating principles of relays - The universal relay - torque equation, RX diagram - CT, PT & applications		
UNIT II	**OPERATING PRINCIPLES AND RELAY FUNCTION**	**9**
Over current relays - directional over current relays - distance relays - differential relays - under frequency and negative sequence relays - Electromagnetic and solid state relays - Time – distance relay, mho relay, numerical relay		
UNIT III	**PROTECTION OF POWER APPARATUS**	**9**
Generator protection - transformer protection - bus zone protection - feeder protection and ring main units - carrier current protection of transmission lines - Relay coordination of a sample system - Industrial power system protection - A.C.motor protection - rectifier protection.		
UNIT IV	**ARCING PHENOMENA AND ITS APPLICATIONS**	**9**
Arcing phenomena and arc quenching - circuit breaker rating RRRV - current chopping and capacitive current breaking characteristics of HRC fuses - DC circuit breaking.		
UNIT V	**CIRCUIT BREAKERS**	**9**
Oil minimum circuit breakers - air blast circuit breakers - vacuum and SF6 circuit breakers - testing of circuit breakers - oil switches - high voltage load breaking switches.		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. B.Ravindranath and N.Chander, "Power Systems protection and switchgear", Wiley Eastern Ltd, 1977. 2. Badri Ram and Viswakarma, D.N., “Power System Protection and Switch Gear”, Tata McGraw-Hill Publishing Company Ltd., 2001.		
REFERENCE BOOKS:		
1. C.L.Wadhwa, "Electric power systems", New Age International (P) Ltd publishers, 1983. 2. S.P.Patra, S.K.Babu and S.Choudhuri, "Power systems protection", Oxford and IBM Publishing Co., 1983. 3. Sunil S. Rao, "Switchgear and protection", Khanna publishers, New Delhi, 1986. 4. Lewis Blackburn “Protective Relaying – Principles and applications”, Second Edition, Dekker Inc., 1998. 5. T.S.Madhava Rao, “Power System Protection Static Relays”, Second Edition, Tata McGraw Hill, 2004		
ONLINE RESOURCES:		
1. https://nptel.ac.in/courses/117107148		

COURSE CODE: **1152EE104**	COURSE TITLE: **HIGH VOLTAGE ENGINEERING**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

This course covers specifications of insulation materials in liquid, gas and solid case and identifies the effect of extra high voltage on the environment. This module will prepare students for effective participation in the field of high voltage power systems within the electrical engineering environment.

PREREQUISITE COURSES:

- Power System Analysis

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand the principles of theory of high voltage generation and measurements
- Understand the operation of high voltage power supplies for ac, dc, and impulse voltages
- Get familiar with various applications where high voltage field is used
- Understand breakdown of HV insulation (solid, Liquid and Gas)
- Understand lightning phenomena and HV Insulation Environmental pollution.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
C01	Explain the principles behind generating high DC-, AC- and impulse voltages	K2
C02	Develop equivalent circuit models of the different high voltage generators	K3
C03	Perform a dynamic response analysis of high voltage measurement system	K2
C04	Illustrate the breakdown strength of gas-filled insulation systems with simple geometries	K2
C05	Explain the principles, concepts, practices relevant to the application and hazards of electrostatic charges within the high voltage field.	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	M									L	H	
CO2	H	M	M	L								L	H	L
CO3	H	M	M	L								L	H	L
CO4	H	M	M									L	H	L
CO5	H	M	M	L		L					L	L	H	

COURSE CONTENT:		
UNIT I	**OVER VOLTAGES AND INSULATION CO ORDINATIONS**	**9**
Introduction – Historical sketch – Comparison between AC and DC transmission – Kinds of DC links – Planning and modern trends. Causes of over voltages in transmission lines - lightning and switching over voltages - effects of over - voltages on power system equipment - protection against over voltages - surge absorbers and surge diverters – shielding - insulation coordination.		
UNIT II	**GENERATION OF HIGH VOLTAGES AND HIGH CURRENT**	**9**
Generation of high AC voltages - cascaded transformers - generation of high DC voltages - Cockcroft Walton circuit and its qualitative analysis - generation of impulse and switching surges - Marx circuit - generation of high impulse current - Tripping and control of impulse generators		
UNIT III	**MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS**	**9**
Measurement of AC, DC impulse and switching surges using sphere gaps, peak voltmeters, potential dividers and high speed CRO, op to Electronics method; Fiber optic method; RIV and corona measurements; partial discharge; dielectric loss measurement using bridges.		
UNIT IV	**ELECTRICAL BREAKDOWN IN GASES, SOLIDS AND LIQUIDS**	**9**
Ionization processes - Townsend & Streamer theory - the sparking voltage - Paschen's law - Time lag for breakdown - Breakdown in non-uniform fields and corona discharges. Conduction and breakdown in pure and commercial liquids and solids dielectrics		
UNIT V	**HIGH VOLTAGE TESTING PRACTICES**	**9**
BS/IEC/VDE specification for testing; correction factor; high voltage testing of power apparatus; corona and RIV testing measurement; Non destructive insulation tests; sources and hazards of EMI and EMC; EMI/EMC testing practice; corona and ESD testing techniques.		
		TOTAL: 45 PERIODS
TEXT BOOKS:		

1. C.L. wadwa " High voltage engineering " New Age International P.Ltd. reprint 2001. (Unit I, II, III, IV,V)
2. M.S.Naidu and N.Kamaraju, "High voltage Engineering" Tata Mc Graw Hill publishing company, New Delhi, 1983
3. Subir Ray, " An introduction to High voltage Engineering", PHI Learning private ltd 2004.
4. John Kuffel and Peter Kuffel, " High voltage engineering fundamentals", second edition, Elsevier.

COURSE CODE: **1152EE105**	COURSE TITLE: **ADVANCES IN POWER SYSTEM**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

This course aims to model the steady-state operation of large-scale power systems and to solve the power flow problems and analyze the stability

PREREQUISITE COURSES:

Power System Analysis

RELATED COURSES:

Power System Protection & Switch gear

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand the harmonics and stability analysis of multi-machine system.
- Gain knowledge on power quality standards
- Familiar with basics of grid and distribution systems and power system networking.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the basics of harmonics and sub harmonics oscillation	K2
CO2	Discuss the Stability analysis of multi-machine system	K2
CO3	Describe the power quality standards, curves and monitoring devices	K2
CO4	Outline the basics of Grid and distribution systems	K2
CO5	Summarize the power system networking, protection and control	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	L									M	H	
CO2	H	M	L									M	H	L
CO3	H	M	L					L				M	H	L
CO4	H	L	L									M	H	
CO5	H	L	L									M	H	L

COURSE CONTENT:

UNIT I	**HARMONICS & SUB HORMONICS OSCILLATION**	**9**

Understanding sub harmonics - sub harmonics in Ferro resonant circuit - sub harmonic protection - harmonic distortion & oscillation – non linear oscillations

UNIT II	**STABILITY OF MULTIMACHINE SYSTEM**	**9**
Transient stabilization of multi machine power system with nontrivial transfer conductance - on-line transient stability analysis - excitation control for multi machine power system		
UNIT III	**POWER QUALITY**	**9**
Power quality issues- standards - power quality monitoring devices - power quality conditioners for smart grid - CBEMA curves		
UNIT IV	**GRID BASED POWER SYSTEM**	**9**
DC micro grid based distribution power generation system – Grid – tied power system - smart grid based solutions applied to power distribution system.		
UNIT V	**POWER SYSTEM NETWORKING**	**9**
Power system network reduction techniques - synchronization and kron reduction in power networks - protection control – EMS - SCADA, RTU, PLC		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. Power System Network Reduction Techniques – Dr.C.Radha Krishnan. 2. Power system stability- Kundur. 3. Power quality- C.sankaran.		
REFERENCE BOOKS:		
1. Power system engineering – Rajput. 2. Understanding the principles of power system harmonics- Arillaga, CRC publications		
ONLINE RESOURCES:		
1. https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-ee13/		

COURSE CODE: **1152EE106**	COURSE TITLE: **SMART GRID**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Elective

PREAMBLE :

To enable the students acquire knowledge on smart grid, different options of architectural design and sensors, measurement technology for various aspects of smart grid, renewable energy sources and storage integration with smart grid.

PREREQUISITE COURSES: Power System Analysis

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand the basic concepts, components and architecture of smart grid
- Understand the various measurement technologies in smart grid
- Educate the importance of renewable energy in smart
- Familiar about the battery technology and energy storage
- Brief about the role of Electric Vehicles in smart grid

COURSE OUTCOMES : *Upon the successful completion of the course, students will be able to:*

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the smart grids components and architecture	K2
CO2	Describe different measuring methods and sensors used in smart grid	K2
CO3	Summarize various renewable energy technologies	K2
CO4	Interpret the role of batteries and energy storages	K2
CO5	Summarize the importance of Electric Vehicles in smart grid	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M			M	L					L		M	
CO2	M	M			M	L					L		M	
CO3	M	M			M	L					L		M	
CO4	M	M			M	L					L		M	
CO5	M	M			M	L					L		M	

COURSE CONTENT:

UNIT I	INTRODUCTION	9

Today's Gird Versus Smart Grid, Rationale for Smart Grid, Computational Intelligence, Power System Enhancement, Communication and Standards, Environment and Economics, Shareholders Roles and Function, Architecture, Functions of Components

UNIT II	**SENSORS AND MEASUREMENT**	**9**
Sensors for Smart Grid, Monitoring and Measurement Technologies, PMU, Smart meters, Smart Appliances, Multi Agent Systems (MAS) Technology, Micro grid and Smart grid comparison, Wide Area Measurement		
UNIT III	**DISTRIBUTED GENERATION**	**9**
Solar Energy, PV Systems, Wind turbine Systems, Biomass, Small and Micro Hydro Power, Fuel Cell, Geothermal heat pumps.		
UNIT IV	**ENERGY STORAGE**	**9**
Batteries, Flow Batteries, Fuel Cell and hydrogen electrolytes, Flywheel, Super conduction magnetic energy storage systems, super capacitors, Simulation and case studies		
UNIT V	**ELECTRIC VEHICLES**	**9**
Plugin Electric Vehicles and hybrid, Vehicle classes, Vehicle Architecture, Gird to Vehicle (G2V) Charging, Grid Impacts, Vehicle to Grid (V2G)		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. James Momoh, “Smart Grid: Fundamentals of design and analysis”, John Wiley & sons Inc, IEEE press 2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko
3. Yokoyama, “Smart Grid: Technology and Applications”, John Wiley & Sons Inc, 2012.
4. Lars.T.Berger, K.Iniewski, “Smart Grid: Applications, Communications & Security” Wiley India Pvt. Ltd, Reprint 2015.

REFERENCE BOOKS:

1. Fereidoon P. Sioshansi, “Smart Grid: Integrating Renewable, Distributed & Efficient Energy”, Academic Press, 2012.
2. Clark W.Gellings, “The smart grid: Enabling energy efficiency and demand response”, Fairmont Press Inc,2009.
3. Qi Huang, Shi Jing “Innovative Testing and Measurement Solutions for Smart Grid”, John Wiley & Sons Inc, 2015.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/108/107/108107113/

COURSE CODE: **1152EE107**	COURSE TITLE: **POWER PLANT ENGINEERING**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

To understand the different methods of power generation; construction and working principle of power plants

PREREQUISITE COURSES:

- Basic Electrical Engineering

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand the performance of thermal and hydro power plants
- Explain the function of nuclear power station
- Understand gas, diesel and non-conventional power plants

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain about thermal power plants	K2
CO2	Describe the features of hydro power plant	K2
CO3	Outline the working of nuclear power plants	K2
CO4	Explain the working of gas and diesel power plant	K2
CO5	Summarize the principle of renewable power plants	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L				L		M				L	H	
CO2	H	L				L	M	L				L	H	
CO3	H	L				L		M				L	H	
CO4	H	L				L		L				L	H	
CO5	H	L				M	H	L				M	H	

COURSE CONTENT:

UNIT I	**THERMAL POWER PLANTS**	**9**

Energy resources and their availability - Types of power plants, selection of the plants - Basic thermodynamic cycles - Various component of steam power plant layout - Pulverized coal burners - luidized bed combustion - Coal handling systems - Ash handling systems - Forced draft and induced draft fans – Boilers Feed pumps - Super heater - Turbines - Regenerator - Condenser - Dearearators – Cooling towers

UNIT II	**HYDRO ELECTRIC POWER PLANTS**	**9**
Layout - Dams - Selection of water turbines - Types - Pumped storage hydel plants		
UNIT III	**NUCLEAR POWER PLANTS**	**9**
Principles of nuclear energy - Basic nuclear reactions - Nuclear power station –Types of Nuclear Reactor - Nuclear Waste disposal.		
UNIT IV	**GAS AND DIESEL POWER PLANTS**	**9**
Types - Open and closed cycle gas turbine - Work output and thermal efficiency - Methods to improve thermal efficiency of gas turbine plant - Reheating - Intercooling - Regeneration and their combinations - Advantages and disadvantages - Comparison with steam power plants problems. Diesel engine power plant – component and layout.		
UNIT V	**NON-CONVENTIONAL POWER GENERATION**	**9**
Solar radiation estimation, solar energy collectors, OTEC, wind power plants, tidal power plants and geothermal resources, fuel cell, MHD power generation -principle, thermoelectric power generation, thermionic power generation.		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Power station Engineering and Economy by Bernhardt G.A.Skrotzki and William A. Vopat - Tata Mc Graw Hill Publishing Company Ltd., New Delhi, 20th reprint 2002.
2. Power Plant Engineering: P.K Nag, Tata McGraw Hill Second Edition 2001.

REFERENCE BOOKS:

1. An Introduction to power plant technology by G.D. Rai-Khanna Publishers, Delhi - 110 005.
2. A Course in Power Plant Engineering by Arora and Domkundwar Dhanpat Rai and Co. Pvt. Ltd., New Delhi.
3. Power Plant Engineering.:M.M. EI-Wakil McGraw Hill 1985.

COURSE CODE: **1152EE108**	COURSE TITLE: **HIGH VOLTAGE DIRECT CURRENT TRANSMISSION**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

This course aims to develop the skills in the area of HVDC power transmission with the analysis of HVDC converters, Reactive power control, and HVDC cables and simulation

PREREQUISITE COURSES:

- Power System

RELATED COURSES:

Transmission and Distribution

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand the concept, planning of DC power transmission and comparison with AC power transmission.
- Acquire knowledge on characteristics of HVDC converters.
- Understand the MTDC system and DC breakers with its characteristics
- Familiar with reactive power and harmonics in HVDC
- Understand the HVDC cables and Modeling of HVDC systems for digital dynamic simulation

COURSE OUTCOMES :

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

CO Nos.	**Course Outcomes**	**Knowledge Level (Based on revised Bloom's Taxonomy)**
CO1	Explain about HVDC concept and planning of power transmission	K2
CO2	Describe the characteristics of HVDC converters	K2
CO3	Explain the MTDC system and DC breakers with its characteristics	K2
CO4	Summarize the reactive power and harmonics in HVDC	K2
CO5	Explain the HVDC cables and Modeling of HVDC systems for digital dynamic simulation	K2

CORRELATION OF COs WITH POs AND PSOs

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	H	M										M	H	L
CO2	H	M										M	H	L
CO3	H	M										M	H	L
CO4	H	M	L									M	H	L
CO5	H	H	M		H						L	M	H	L

COURSE CONTENT:		
UNIT I	**BASIC CONCEPTS**	**9**
Introduction of DC Power transmission technology – Comparison of AC and DC transmission – Application of DC transmission – Description of DC transmission system – Planning for HVDC transmission – Modern trends in DC transmission.		
UNIT II	**ANALYSIS OF HVDC CONVERTERS**	**9**
Pulse number – Choice of converter configuration – Simplified analysis of Graetz circuit – Converter bridge characteristics – Characteristics of a twelve pulse converter – Detailed analysis of converters.		
UNIT III	**MULTI TERMINAL HVDC SYSTEMS**	**9**
Types of MTDC system – Comparison of series and parallel MTDC system – HVDC insulation – DC line insulators – DC breakers – Characteristics and types of DC breakers		
UNIT IV	**REACTIVE POWER AND HARMONICS IN HVDC**	**9**
Sources of reactive power - static VAR system – Reactive power control during transients – Generation of harmonics – Types and design of various DC filters – interference telephone.		
UNIT V	**HVDC CABLES AND SIMULATION OF HVDC SYSTEMS**	**9**
Introduction of DC cables – Basic physical phenomenon arising in DC insulation – Practical dielectrics – Dielectric stress consideration – Economics of DC cables compared with AC cables. Introduction to system simulation – Philosophy and tools – HVDC system simulation – Modeling of HVDC systems for digital dynamic simulation.		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. Padiyar, K. R., “HVDC power transmission system”, Wiley Eastern Limited, New Delhi Third Edition. 2015. 2. 2. S. Rao, “EHV-AC, HVDC Transmission and Distribution Engineering”, Third Edition. 2013.		
REFERENCE BOOKS:		
1. Colin Adamson and Hingorani N G, “High Voltage Direct Current Power Transmission”, Garraway Limited, London, 1960. 2. Arrillaga, J., “High Voltage Direct Current Transmission”, Peter Pregrinus, London, 1983. 3. Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering”, New Age Interantional (P) Ltd., New Delhi, 1990.		

COURSE CODE: **1152EE109**	COURSE TITLE: **LOAD FORECASTING AND GENERATION FORECASTING**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

This course aims to understand the concepts of load forecasting and generation forecasting

PREREQUISITE COURSES:

- Power System operation and control

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand basic concepts of load forecasting and load management
- Understand the energy demand forecasting and its planning

COURSE OUTCOMES :

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

COs	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the load forecasting methods	K2
CO2	Summarize the Basics about energy management	K2
CO3	Illustrate the energy demand forecasting and its methodologies	K2
CO4	Explain the energy management strategy and case studies about energy forecasting	K2
CO5	Describe the planning of generation depending on forecasting	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H					L						M	H	L
CO2	H	L				L	H					M	H	L
CO3	H	M										M	H	L
CO4	H	M	M				L				L	M	H	L
CO5	H	M	M			M					L	M	H	L

COURSE CONTENT:

UNIT I	**LOAD FORECASTING**	**9**

Classification and characterization of loads - Approaches to load forecasting - Forecasting methodology - Energy forecasting - Peak demand forecasting - Nonweather sensitive forecast and Weather sensitive forecast - Total forecast - Annual and monthly peak demand forecasts - Applications of state estimation to load forecasting.

UNIT II	**LOAD MANAGEMENT**	**9**

Introduction to Load management - Electric energy production and delivery system structure (EEPDS) - Design alternatives for EEPD systems - Communication/control techniques for load management - Tariff structure and load management - principles of macro and microeconomics and energy pricing strategies - Assessing the impacts of load management.		
UNIT III	**ENERGY DEMAND FORECASTING**	**9**
Static and dynamic analysis of energy demand - Elements of energy demand forecasting - Methodologies and models for energy demand forecasting - Techno economic approach in energy demand forecasting - Energy auditing - Energy management Power Pools and Energy Banking.		
UNIT IV	**TRENDS AND CASE STUDIES**	**9**
Energy management strategy - Symbiotic relation between information - Energy models and decision making - Case studies like industrial energy forecasting - Transportation energy forecasting - Residential, Commercial and agricultural energy forecasting		
UNIT V	**FORECASTING AND PLANNING**	**9**
The role of forecasting in planning – comparison and selection of forecasting methods. The accuracy of forecasting methods – Pattern of the Data and its effects on individual forecasting methods - Time horizon effects on forecasting methods - Generation planning-fundamental economic analysis - Generation planning optimized according to generating unit categories distribution & transmission system planning		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. Power System Network Reduction Techniques – Dr.C.Radha Krishnan. 2. Power quality- C.sankaran. 3. Power system stability- Kundur.		
REFERENCE BOOKS:		
1. Power system engineering – Rajput. 2. Understanding the principles of power system harmonics- Arillaga, CRC publications		
ONLINE RESOURCES:		
1. https://nptel.ac.in/courses/108105104		

COURSE CODE: **1152EE110**	COURSE TITLE: **LOAD DISPATCHING**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

This course aims to provide the knowledge on objectives, function and location of load dispatch centres

PREREQUISITE COURSES

- Basic Electrical Engineering

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand the basics of integrated power systems
- Acquire knowledge on function and location of load dispatch centres
- Familiar with equipment and general arrangement of control room at load dispatch centres
- Gain knowledge on telecommunication in power system operation
- Understand contingencies of operating reserve and its maintenance

COURSE OUTCOMES :

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

COs	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Outline the basics of integrated power systems	K2
CO2	Explain the function and location of load dispatch centres	K2
CO3	Illustrate the equipment and general arrangement of control room at load dispatch centres	K2
CO4	Describe the telecommunication in power system operation	K2
CO5	Explain the contingencies of operating reserve and its maintenance	K2

CORRELATION OF COs WITH POs AND PSOs

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M										L	H	
CO2	H	M	L									L	H	L
CO3	H	M	L									L	H	L
CO4	H	M										L	H	
CO5	H	M	M									L	H	

COURSE CONTENT:		
UNIT I	**INTRODUCTION**	**9**
Development of integrated Power Systems - Benefits of operation of integrated power systems - Reduction in generating capacity due to the diversity of load demands - Reduction in standby capacity - increase in the size of generating sets.		
UNIT II	**OBJECTIVES, FUNCTION AND LOCATION OF LOAD DISPATCH CENTRES**	**9**
Objectives- Load dispatch centres and control centres - Function of the modern control centre – Operational Planning of a power systems – Aspects of the operational planning of systems		
UNIT III	**FACILITIES AT LOAD DISPATCH CENTRES**	**9**
Equipment and General arrangement - Building, Control room - Mosaic Diagram - Mimic Board - Designing of control room and facilities of control room		
UNIT IV	**TELECOMMUNICATIONS IN POWER SYSTEM OPERATION**	**9**
General-Telecommunications in power system operation – Various power system - communication media - PLCC, Radio Circuits, Leased Telephone Circuits, Fibre Optics and Satellite Communication - Communication systems.		
UNIT V	**DETERMINATION OF OPERATING RESERVE**	**9**
General of operating Reserve - Contingencies of operating reserve-General practice regarding the maintenance - Problems of operating reserves.		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Power System Network Reduction Techniques – Dr.C.Radha Krishnan.
2. Power system stability- Kundur.

REFERENCE BOOKS:

1. Power system engineering – Rajput.
2. Understanding the principles of power system harmonics- Arillaga, CRC publications
3. Advanced load dispatch for power systems- Mariani.E, Murthy.S.S

COURSE CODE:**1152EE144**	COURSE TITLE: **REACTIVE POWER MANAGEMENT**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

It is aimed to provide the importance of reactive power in electric power network.

PREREQUISITE COURSES:

- Circuit Analysis
- Transmission and Distribution

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Identifying the necessity of reactive power compensation and Describing the role of reactive power in electrical network
- Imparting various types of reactive power compensation in transmission systems
- Describing the effect of reactive power for HVDC systems
- Underlying the importance of FACTS devices
- Illustrating reactive power coordination system for renewable energy systems

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Highlight the importance of reactive power and voltage control in power system	K2
CO2	Explain the effect of reactive power on generation and transmission systems	K2
CO3	Explain the effect of reactive power in HVDC transmission systems	K2
CO4	Specify the importance of FACTS devices and its applications	K2
CO5	Indicate the effect of reactive power in grid connected renewable energy systems	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		L	L								L	H	L
CO2	M		L	M								L	H	L
CO3	M		L	M	L								H	L
CO4	L		L	L	L					L		L	H	L
CO5	L		L	L	L					M		L	H	L

COURSE CONTENT:		
UNIT I	**INTRODUCTION**	**9**
Introduction to Reactive Power – Analogy Examples – Sources and Sinks of Reactive Power – Voltage Control through Static and Dynamic sources of Reactive Power – Different types of Loads and Reactive Power Consumption – Procedure for Controlling Voltage and Reactive Power - Methods for Power Factor Improvement.		
UNIT II	**EFFECT OF REACTIVE POWER ON GENERATION AND TRANSMISSION**	**9**
Generator - Reactive power capability curve - Synchronous condenser - Introduction to transmission line model – Surge impedance loading –Thermal loading of transmission lines – Methods of voltage control - Shunt reactors and reactive power control – Series and shunt capacitors – Comparison between series and shunt compensation – OLTC effect on reactive power.		
UNIT III	**EFFECT OF REACTIVE POWER ON HVDC SYSTEMS**	**9**
Introduction to HVDC –Effects on reactive power - Voltage source converters – Interaction between two neighboring HVDC systems – HVDC Bi-pole configuration – HVDC Back to Back configuration.		
UNIT IV	**ROLE OF FACTS DEVICES**	**9**
Introduction to FACTS – Static VAR compensators – Functions – Types – Characteristics – Modes of operation – Converter based compensators – STATCOM – Series connected controllers – Thyristor Switched Series Capacitor (TSSC) - Thyristor Controlled Series Capacitor (TCSC) – Thyristor Switched Series Reactor (TSSR) – Thyristor Controlled Series Reactor (TCSR).		
UNIT V	**REACTIVE POWER MANAGEMENT FOR RENEWABLE ENERGY SYSTEMS**	**9**
Reactive power influence on voltage and transient stability – Reactive power requirements and capabilities for wind generators – Capability Curves – Various control objectives – Reactive power capability of solar PV generator – Control schemes in inverter circuit in solar PV system for reactive power support – Reactive power support devices – Control strategies for reactive power management in renewable energy systems		
		TOTAL: 45 PERIODS

TEXTBOOKS:

1. D.M.Tagare, Reactive power Management, Tata McGraw Hill, 2004.
2. Reactive Power Management – A resource handbook, National Load Dispatch Centre, New Delhi, Dec, 2013.

REFERENCE BOOKS:

1. J.E.Miller, Reactive Power Control in Electric Power Systems, John Wiley and Sons, 1982.
2. Mohammad Nazmul Islam Sarkar et al., “Reactive Power Management in Renewable Rich Power Grids: A Review Grid Codes, Renewable Generators, Support Devices, Control Strategies and Optimization Algorithms”, IEEE Access, 2018, DOI : 10.1109/ACCESS.2018.2838563

COURSE CODE: **1152EE111**	COURSE TITLE: **LED LIGHTING TECHNOLOGY**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Elective

PREAMBLE :

This course forms the basis for understanding the types and fabrication of LEDs also it aims to discuss about the significance of driver circuits used in LED lighting system. The control strategies used in lighting of LED based systems are discussed so as to provide knowledge in design and analysis of LED based system. Lastly, the course also provides basic hands on exposure on assembly techniques for developing LED based products

PREREQUISITE COURSES: Power Electronics & Drives

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- State the need for Illumination.
- Define good Illumination.
- State what comprises an electric utility?
- List standard voltage levels.
- Power electronics as applied to LED technology
- Define the aspects of design of lighting systems
- Maintain the lighting systems
- Fault rectification of lighting systems

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the fundamental elements, laws and quantities of illumination and optical design	K2
CO2	Explain about LED lighting, types of lightings	K2
CO3	Identify the constructional features, parts and working of illumination systems	K2
CO4	Discuss and design the types and working of power electronic circuits used in LED technology	K3
CO5	Develop the Lighting control strategies, building lighting control systems and applications Design and fabricate PCB for LED lighting system, repair, maintenance of LED systems	K3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		H					M						
CO2		M				M								
CO3	H		M					M		M				H

CO4					M									M
CO5		L		M							M			H

COURSE CONTENT:

UNIT I	**LIGHT AND ILLUMINATION**	**9**

Basics about Light: Electromagnetic Spectrum, Visible Spectrum, Wavelength, Characterizations, Classification of Radiometry & Photometry - Natural & Artificial Light Sources - Characteristics about Light - Light and Vision - Evolution of Lighting Technologies - Merits and Demerits of the technologies - Instruments used for Measurement of Light Quantities.

UNIT II	**LED TECHNOLOGY**	**9**

Physics of a LED - Electrical characteristics - Optical characteristics - Data Sheet interpretation - Types of LED's - Experimental Procedures for determination of the Characteristics - White LED Parameters - Solid State Luminaire - Solid State Luminaire Standards - Performance Measurements.

UNIT III	**POWER ELECTRONICS FOR LED LIGHTING**	**9**

LED Driver Requirements and Regional Standards – Topology Overview - Linear, Buck, Boost, Buck-Boost, Sepic & Fly-back) - Driving options - Discrete based drivers, Linear drivers, Switching drivers - AC-DC Drivers, Importance of Power Factor Correction (PFC), Single Stage vs 2-Stage Design, TRIAC Dimmable AC-DC Drivers - PWM IC

UNIT IV	**LIGHT POWER & CONTROL**	**9**

Lighting control strategies, techniques & equipment, sensors and timers, switches versus dimming control algorithm, harmonics, EI from lighting equipment – its measurement & suppression techniques. Impact of lighting control, protocols for lighting control; Lighting control by computer, simple multi-channel & large multi-channel control, stage & entertainment lighting control, architectural & building lighting control systems; Centralised vs. distributed system; Status monitoring, fault monitoring, electrical load monitoring, lamp life monitoring system, applications

UNIT V	**LED MANUFACTURING TECHNOLOGY**	**9**

Design Fundamentals of LED Lamps - Testing Of LED Lamps – SMD PCB Assembly technology – Screen printing, Pick & place Machines programming & practice, Reflow soldering, Hand Soldering, SMD REWORK & Repair, Dispensing, Coating, protection Optional

ADVANCED: LED Packaging process- Diebonding, Wire bonding, Encapsulation etc.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Optoelectronic Devices and Circuits, Theory and Applications, Amar K.Ganguly, Narosa Publishing House
2. Power Electronics, Dr.P.S.Bimbhra, Khanna Publishers.

REFERENCE BOOKS:

1. LIGHT-EMITTING DIODES E. FRED SCHUBERT, Cambridge University Press The Edinburgh Building, Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore.
2. Light Design, Anil Valia, Published by Mili Jain

COURSE CODE: **1152EE112**	COURSE TITLE: **FLEXIBLE AC TRANSMISSION SYSTEMS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

This course will describe about basic concepts, different types, scope and applications of FACTS controllers in power transmission system

PREREQUISITE COURSES:

o Power electronics & Drives

RELATED COURSES:

o Electric Circuit Theory, Power System, Power electronics, Digital electronics

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Know the importance of compensation in transmission lines and the concepts of FACTS devices.
- Illustrate the design, modeling and applications of SVC.
- Familiar with the operation, modes, modeling and applications of TCSC.
- Study the principle, characteristics, modeling and applications of STATCOM and SSSC.
- Summarize about the importance in coordination of FACTS controllers.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the basic fundamental of FACTS controllers	K2
CO2	Summarize about Static VAR Compensators	K2
CO3	Explain about Modeling, Operation and control strategies of Static series compensation-SVC	K2
CO4	Explain the voltage source based FACTS controllers	K2
CO5	Explain the modeling and design of Coordinating multiple FACTS controllers using control techniques	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L									L	M	H	L
CO2	H	L	L								L	M	H	L
CO3	H	L	L								L	M	H	L
CO4	H	L	L								L	M	H	L
CO5	H	L	L								L	M	H	L

COURSE CONTENT:		
UNIT I	**INTRODUCTION TO FACTS**	**9**
Reactive power control in electrical power transmission lines –Uncompensated transmission line - Power Flow in AC System – relative - importance of controllable parameter –opportunities for FACTS – possible benefits for FACTS.		
UNIT II	**STATIC VAR COMPENSATOR (SVC) AND APPLICATIONS**	**9**
Need for compensation – introduction to shunt & series compensation – objectives of shunt & series compensation – configuration & operating characteristics, Static shunt compensators: SVC - Operation and control.		
UNIT III	**SERIES COMPENSATION AND APPLICATIONS**	**9**
Static series compensation: TSSC - Modeling, Operation and control, Different modes – Variable reactance model –Applications: Improvement of the system stability limit – Enhancement of system damping.		
UNIT IV	**VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS**	**9**
Static Synchronous Compensator (STATCOM) – Principle of operation – V-I Characteristics - Applications: Steady state power transfer-Enhancement of transient stability - Prevention of voltage instability - SSSC-operation of SSSC and the control of power flow –Modeling of SSSC in load flow and transient stability studies.		
UNIT V	**CO-ORDINATION OF FACTS CONTROLLERS**	**9**
Introduction to Unified Power Flow Controller (UPFC) & Interline Power Flow Controller (IPFC) – basic operating principles UPFC – introduction to sub synchronous Resonance - Coordination of multiple controllers using linear control techniques. Introduction to SCADA and security monitoring.		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Narain G. Hingorani and Laszlo Gyugyi, “Understanding FACTS – Concepts and Technology of Flexible AC Transmission Systems”, Standard Publishers, New Delhi, 2001.
2. R. Mohan Mathur and Rajiv K. Varma, “Thyristor Based FACTS Controller for Electrical Transmission Systems”, Wiley Inter science Publications, 2002

REFERENCE BOOKS:

1. Padiyar K.R.,” FACTS Controllers in Power Transmission and Distribution”, New Age International (P) Limited, Publishers, New Delhi, 2008.
2. Narain G. Hingorani, “Flexible AC Transmission”, IEEE Spectrum, April 1993, 40-45
3. Narain G. Hingorani, “High Power Electronics in Flexible AC Transmission”, IEEE Power Engineering Review, 1998.
4. Elinar V. Larsen, Juan J Sanchez – Gasca Joe H. Chow, “Concepts for design of FACTS controllers to damp power swings”, IEEE Transactions on Power Systems, Vol. 10, No. 2, May.1995.
5. Miller. T.J.E., Reactive Power Control in Electric System, John Wiley & Sons, 1997.

COURSE CODE: **1152EE113**	COURSE TITLE: **MODERN POWER CONVERTERS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

In this course student will get exposure to basic principle of operation, structure, characteristics of power converters.

PREREQUISITE COURSES:

Power Electronics & Drives

RELATED COURSES:

Solid state AC & DC drives, Advanced Semiconductor Devices

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Explaining about the Single phase bridge rectifiers with RL, RLE loads & effect of source impedance
- Explaining about the three phase bridge rectifiers with RL, RLE loads & effect of source impedance
- Teaching about design and analysis of dc –dc converters
- Presentation on single-phase bi-directional controllers with R, L and R-L loads, 3-phase controllers.
- Explicate the single phase and three phase cycloconverters.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the types loads with single phase thyristor controlled converter.	K2
CO2	Describe the operation, characteristics and performance parameters three phase thyristor controlled converter.	K2
CO3	Identify the types of dc-dc converters.	K2
CO4	Explain the single-phase bi-directional controllers with R, L and R-L loads & 3-phase controllers	K2
CO5	Describe the principle of operation of single phase and three phase Cycloconverters	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L										L	H	L
CO2	H	M	L										H	L
CO3	H	M	L										H	
CO4	H	M	L									L	H	L
CO5	H	L											H	

COURSE CONTENT:		
UNIT I	**SINGLE PHASE AC TO DC CONVERTERS**	**9**
Single phase bridge rectifiers, half controlled and Fully controlled converters with RL, RLE loads, freewheeling diodes, Dual Converter, sequence control of converters-inverter operation, Input harmonics and output ripple, smoothing inductance-power factor, effect of source impedance and overlap ,reactive power and power balance in converter circuits.		
UNIT II	**THREE PHASE AC TO DC CONVERTERS**	**9**
Semi and Fully controlled converters with R, RL, RLE loads, freewheeling diodes, Dual Converter, sequence control of converters-inverter operation, Input harmonics and output ripple, smoothing inductance-power factor, effect of source impedance and overlap, 12 pulse converter.		
UNIT III	**DC TO DC CONVERTERS**	**9**
Principle of operation, choice of communication circuit elements, Step down and step up choppers, classification, Voltage and current commutated choppers, effect of source Inductance, Filter circuits, multiphase chopper, resonant converters.		
UNIT IV	**AC VOLTAGE CONTROLLERS**	**9**
Principle of phase control, single-phase bi-directional controllers with R, L and R-L loads, 3-phase controllers, different configurations, Analysis with pure R and L loads.		
UNIT V	**CYCLOCONVERTERS**	**9**
Principle of operation, single phase and three phase cyclo converters, Power circuits, gating signals-harmonics and analysis of power factor		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. Rashid M.H., “Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Second Edition, New Delhi, 1995. 2. P.C Sen.," Modern Power Electronics ", Wheeler publishing Co, First Edition, New Delhi-1998.		
REFERENCE BOOKS:		
1. Mohan N., Undeland and Robbins, “Power Electronics-Converters ", Applications and Design ", John Wiley and sons, Inc., New York, 1995.		
ONLINE RESOURCES:		
1. https://nptel.ac.in/courses/117103148		

COURSE CODE: **1152EE114**	COURSE TITLE: **AUTOMOTIVE ELECTRICAL & ELECTRONIC SYSTEMS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program **Elective**

PREAMBLE :

The course is aimed at imparting fundamental knowledge about the electrical layout and to understand the various sensors and related control system assembly within an automobile.

PREREQUISITE COURSES:

Basic Electronics Engineering, Basic Mechanical Engineering

RELATED COURSES:

Automobile Engineering, Electrical Machines

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Introduce the basic layout of an automotive electrical system
- Introduce about the Starting and Charging systems of a vehicle.
- Introduce about the Sensors and Actuators used in an Automobile.
- Introduce about the control systems within a vehicle.
- Introduce about the basic management system within a vehicle.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
C01	Emphasize the basic architecture of Automotive Electrical systems.	K2
C02	Illustrate the problems behind the drives employed in a vehicle.	K2
C03	Relate the sensor arrangements in a vehicle	K2
C04	Explain the control strategies on a vehicle	K2
C05	Outline the parameters to be controlled for the Engine management system.	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L									L	H	L
CO2	H	M	L									L	H	L
CO3	H	M	L	L								L	H	L
CO4	H	M	L	L								L	H	L
CO5	H	M	L	L								L	H	L

COURSE CONTENT:		
UNIT I	**INTRODUCTION TO AUTOMOTIVE ELECTRICAL SYSTEM**	**9**
Automotive Electrical Layout, Automotive component operation, Electrical wiring terminals, Circuit diagrams and symbols On Board Diagnostics, Dash Board instruments, Warning Systems, Fault Diagnosis and troubleshooting.		
UNIT II	**STARTING & CHARGING SYSTEMS**	**9**
Condition at starting, behavior of starter during starting, series motor and its characteristics, principle and construction of starter motors& driving mechanism, D.C. Generator and Alternator-Maintenance of Drives- Regulation for Charging, lighting lamps and Fuses.		
UNIT III	**AUTOMOTIVE SENSORS**	**9**
Introduction, Basic Sensor Arrangement, Types of sensors, Oxygen Sensor, Cranking Sensor, Position Sensor, Engine cooling water Sensor, engine oil pressure sensor, Flow sensor, Temperature and humidity sensor, Speed and Acceleration sensor, Knock sensor, Torque sensor, Yaw rate sensors		
UNIT IV	**AUTOMOTIVE CONTROL SYSTEMS**	**9**
Automotive microcontrollers, Engine Control Systems, Transmission Control System, Cruise Control System, Braking Control System, Traction Control System, Stability Control System, Suspension Control System, Steering Control System		
UNIT V	**ENGINE MANAGEMENT SYSTEM**	**9**
Engine-Construction & stroke Classification-Sensor arrangements in Engine, Open & Closed loop Control, engine cooling and warm up control, acceleration, detonation and idle speed control, exhaust emission control engineering		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. "Understanding Automotive Electronics", by Mr. William B. Ribbens, Norman P. Mansour, Elsevier, 2012
2. "Automotive Electrical Equipment" by Mr.P L Kohli, Tata McGraw-Hill Education, 2004.
3. "Automobile Electrical and Electronics Systems", by Mr. Tom Denton, Elsevier, 4 edition (April 9, 2012)

REFERENCE BOOKS:

1. Robert Bosch-: Automotive Handbook- SAE- 2011 Edition I.
2. Dr. Kirpal Singh -: Automobile Engineering, standard publishers , Vol- 1and Vol- 2, -2012
3. Judge- A.W. -: Modern Electrical Equipment of Automobiles- Chapman and Hall- London- 2011.
4. R.K. Jurgen- Automotive Electronics Handbook- McGraw Hill 2ndEdition 2010

COURSE CODE: **1152EE115**	COURSE TITLE: **FUNDAMENTALS OF ELECTRIC & HYBRID VEHICLES**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program **Elective**

PREAMBLE :

This course aims in providing the fundamental knowledge on electric and hybrid power trains, principle of regenerative braking and environmental advantages of electric & hybrid vehicles.

PREREQUISITE COURSES:

Basic Electrical & Electronics Engineering, Basic Mechanical & Construction Engineering

RELATED COURSES:

Electrical Machines

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Impart the knowledge on vehicle propulsion principle
- Understand the electric vehicles and its powertrains
- Get fundamental knowledge on hybrid electric vehicles
- Understand regenerative braking in electric vehicles
- Know the advantages of electric vehicles in various environment

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
C01	Enumerate the principle of vehicle propulsion and braking.	K2
C02	Outline the principle & performance of an electric vehicle.	K2
C03	Illustrate the working principle of a Hybrid Electric Vehicle.	K2
C04	Explain the braking system of EV, HEV and FCV.	K2
C05	Articulate the effects of electric and hybrid vehicles on environment	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L			L					M	M	H	M
CO2	H	M	L			L					M	M	H	M
CO3	H	M	L			L					M	M	H	M
CO4	H	M	L			L					M	M	H	M
CO5	H	M	L			L	M				M	M	H	M

COURSE CONTENT:		
UNIT I	**FUNDAMENTALS OF VEHICLE PROPULSION**	**9**
General Description of Vehicle Movement - Vehicle Resistance - Dynamic Equation - Power Train Tractive Effort and Vehicle Speed - Vehicle Power Plant and Transmission Characteristics - Vehicle Performance - Operating Fuel Economy - Brake Performance		
UNIT II	**ELECTRIC VEHICLE& PROPULSION SYSTEMS**	**9**
Configurations of EVs - Performance of EVs - Traction Motor Characteristics - Tractive Effort and Transmission Requirement - Vehicle Performance - Tractive Effort in Normal Driving- Energy Consumption - Principle of Operation and Performance - DC Motor Drives - Induction Motor Drives - Permanent Magnet BLDC Motor Drives - SRM Drives		
UNIT III	**HYBRID ELECTRIC VEHICLES**	**9**
HEV-Types of HEVs-Series & Parallel HEVs-Advantages & Disadvantages – Series - Parallel Combination - Design of an HEV - Hybrid Drive trains - sizing of components - rated vehicle velocity		
UNIT IV	**REGENERATIVE BRAKING**	**9**
Braking Energy Consumed in Urban Driving - Braking Energy versus Vehicle Speed - Braking Energy versus Braking Power - Braking Energy versus Braking Power - Braking Energy versus Vehicle Deceleration Rate - Braking Energy on Front and Rear Axles - Brake System of EV, HEV, and FCV - Parallel Hybrid Braking System - Fully Controllable Hybrid Brake System		
UNIT V	**ELECTRIC VEHICLES & ENVIRONMENT**	**9**
Vehicle Pollution: the Effects - Vehicles Pollution: a Quantitative Analysis - Vehicle Pollution in Context - Alternative and Sustainable Energy Used via the Grid - Using Sustainable Energy with Fueled Vehicles - The Role of Regulations and Law Makers - Case study of rechargeable battery vehicles.		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Husain I. Electric and hybrid vehicles: design fundamentals. CRC press; 2011 Jun 27.
2. Larminie, James, and John Lowry. "Electric vehicle technology explained, 2003." John Wiley&Sons, Ltd.
3. Ehsani, Mehrdad, Yimin Gao, and Ali Emadi. Modern electric, hybrid electric, and fuel cell vehicles: fundamentals, theory, and design. CRC press, 2009.

REFERENCE BOOKS:

1. Emadi, Ali, ed. Handbook of automotive power electronics and motor drives. CRC press, 2005.
2. Soylu, Seref, ed. Electric Vehicles: The Benefits and Barriers. InTech, 2011.
3. Soylu, Seref. "Electric Vehicles–Modelling and Simulations" InTech Europe, Rijeka, Croatia (2011).

ONLINE RESOURCES:

1. https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-ee18/

COURSE CODE: **1152EE116**	COURSE TITLE: **SPECIAL ELECTRICAL MACHINES**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program **Elective**

PREAMBLE :

This course exposes the students to the construction, principle of operation and performance of special electrical machines as an extension to the study of AC & DC electrical machines.

PREREQUISITE COURSES:

Basic Electrical Engineering, DC Machines and Transformers, AC Machines

RELATED COURSES:

AC Machines, DC Machines & Transformers

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Familiar with the Construction, principle of operation and performance of synchronous reluctance motors, stepping motors, switched reluctance motors, permanent magnet brushless D.C. motors, permanent magnet synchronous motors.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's taxonomy)
CO1	Explain the Construction, principle of operation and performance of synchronous reluctance motors.	K2
CO2	Outline the control scheme for stepper motors	K2
CO3	Summarize the performance characteristics and control of switched reluctance motors	K2
CO4	Illustrate the operation and control of permanent magnet brushless D.C. motors.	K2
CO5	Interpret operating characteristics of permanent magnet synchronous motors.	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		L								L	L	M	L
CO2	H		L								L	L	M	L
CO3	H		L								L	L	M	L
CO4	H		L								L	M	M	L
CO5	H		L								L	L	M	L

COURSE CONTENT:		
UNIT I	**SYNCHRONOUS RELUCTANCE MOTORS**	**9**
Constructional features – Types – Axial and Radial flux motors – Operating principles – Variable Reluctance and Hybrid Motors – SYNREL Motors – Voltage and Torque Equations - Phasor diagram- Characteristics.		
UNIT II	**STEPPER MOTOR**	**9**
Constructional features – Principle of operation – Variable reluctance motor – Hybrid motor – Single and multi stack configurations – Torque equations – Modes of excitations – Characteristics – Drive circuits – Microprocessor control of stepper motors – Closed loop control.		
UNIT III	**SWITCHED RELUCTANCE MOTORS**	**9**
Constructional features – Rotary and Linear SRMs - Principle of operation – Torque production – Steady state performance prediction- Analytical method -Power Converters and their controllers –Methods of Rotor position sensing – Sensorless operation – Closed loop control of SRM -Characteristics.		
UNIT IV	**PERMANENT MAGNET BRUSHLESS D.C. MOTORS**	**9**
Permanent Magnet materials – Magnetic Characteristics – Permeance coefficient -Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations –Commutation – Power controllers – Motor characteristics and control.		
UNIT V	**PERMANENT MAGNET SYNCHRONOUS MOTORS**	**9**
Principle of operation – Ideal PMSM – EMF and Torque equations – Armature reaction MMF – Synchronous Reactance – Sinewave motor with practical windings - Phasor diagram – Torque/speed characteristics - Power controllers - Converter Volt-ampere requirements.		
TOTAL: 45 PERIODS		

TEXT BOOKS:

1. T.J.E. Miller, 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press, Oxford, 1989.
2. 2. T. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 1984.

REFERENCE BOOKS:

1. R.Krishnan, 'Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design

COURSE CODE: **1152EE117**	COURSE TITLE: **ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

To make the student understand electromagnetic interference and compatibility

PREREQUISITE COURSES:

Electromagnetic Theory

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand the EMC regulation and methods of eliminating interferences
- Familiar with the Methods of grounding of cable shield
- Understand the concept of filtering and shielding
- Impart knowledge on types of digital circuit noises
- Understand the electrostatic discharge and standards.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the EMC regulation and methods of eliminating interferences	K2
CO2	Explain the Methods of grounding of cable shield	K2
CO3	Describe the concept of filtering and shielding	K2
CO4	Outline the types of digital circuit noises	K2
CO5	Illustrate about the electrostatic discharge and standards.	K2

CORRELATION OF COs WITH POs AND PSOs

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L		L								L	M	
CO2	H										L		M	
CO3	H	H									L		M	
CO4	H		M									L	M	
CO5	H	H		H								L	M	

COURSE CONTENT:

UNIT I	**INTRODUCTION**	**9**

Sources of EMI, Conducted and radiated interference - Characteristics - Designing for

electromagnetic compatibility (EMC) - EMC regulation- typical noise path - use of network theory - methods of eliminating interferences.		
UNIT II	**METHOD OF HARDENING**	**9**
Cabling – capacitive coupling - inductive coupling- shielding to prevent magnetic radiation-shield transfer impedance, Grounding – safety grounds – signal grounds - single point and multipoint ground systems - hybrid grounds- functional ground layout – grounding of cable shields - ground loops - guard shields.		
UNIT III	**BALANCING, FILTERING AND SHIELDING**	**9**
Power supply decoupling - decoupling filters - amplifier filtering – high frequency filtering shielding – near and far fields - shielding effectiveness - absorption and reflection loss, Shielding with magnetic material - conductive gaskets, windows and coatings - grounding of shields.		
UNIT IV	**DIGITAL CIRCUIT NOISE AND LAYOUT**	**9**
Frequency versus time domain - analog versus digital circuits - digital logic noise - internal noise sources- digital circuit ground noise – power distribution-noise voltage objectives - measuring noise voltages - unused inputs - logic families.		
UNIT V	**ELECTROSTATIC DISCHARGE,STANDARDS AND LABORATORY TECHNIQUES**	**9**
Static Generation - human body model - static discharges-ED protection in equipment design - ESD versus EMC, Industrial and Government standards – FCC requirements – CISPR recommendations - Laboratory techniques - Measurement methods for field strength - EMI.		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Henry W.Ott, " Noise reduction techniques in electronic systems", John Wiley & Sons, 1989.
2. Bernhard Keiser, "Principles of Electro-magnetic Compatibility", Artech House, Inc. (685 canton street, Norwood, MA 020062 USA) 1987.
3. Bridges, J.E Milleta J. and Ricketts.L.W., "EMP Radiation and Protective techniques", John Wiley and sons, USA 1976.
4. IEEE National Symposium on "Electromagnetic Compatibility", IEEE, 445, hoes Lane, Piscataiway, NJ 08855.

COURSE CODE: **1152EE118**	COURSE TITLE: **SOLID STATE DRIVES**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

This course Solid State Drives, provides an introduction to the operation of electric drives controlled from a power electronic converter and also provides the design concepts of controllers

PREREQUISITE COURSES:

Electrical machines, Power Electronics

RELATED COURSES:

Special Electrical Machines

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand the stable steady-state operation and transient dynamics of a motor-load system.
- Study and analyze the operation of the converter / chopper fed dc drive and to solve simple problems.
- Study and understand the operation of both classical and modern induction motor drives.
- Understand the differences between synchronous motor drive and induction motor drive and to learn the basics of permanent magnet synchronous motor drives.
- Analyze and design the current and speed controllers for a closed loop solid-state d.c motor drive

COURSE OUTCOMES :

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

CO Nos.	**Course Outcomes**	**Knowledge Level (Based on revised Bloom's Taxonomy)**
CO1	Explain the concept of AC AND DC drive system	K2
CO2	Illustrate the operation of the converter / chopper fed dc drive and to solve simple problems	K2
CO3	Explain the operation of both classical and modern induction motor drives	K2
CO4	Interpret the operation of synchronous motor drives	K2
CO5	Explain the operation of special machine drives and its applications.	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	L								L	L	H	L
CO2	H	H	M								L	L	H	L
CO3	H	H	M								L	L	H	L
CO4	H	H	H								L	L	H	L
CO5	H	H	M								L	L	H	L

COURSE CONTENT:

UNIT I	**FUNDAMENTALS OF ELECTRIC DRIVES**	**9**

Advantage of electric drives – Parts and choice of electrical drives – Status of DC and AC drives – Torque-speed characteristics of motor and load – Selection of motor power rating – Thermal model of motor for heating and cooling – Classes of duty cycle – Determination of motor rating – Control of electric drives – Modes of operation – Speed control and drive classifications – Closed loop control of drives.

UNIT II	**CONVERTER / CHOPPER FED DC MOTOR DRIVE**	**9**

Steady state and transient analysis of the single and three phase fully controlled converter fed separately excited D.C motor drive – Continuous and discontinuous conduction mode – Multiquadrant operation– Converter control – Chopper-fed D.C drive – Steady-state analysis – Block diagram of closed loop dc drive.

UNIT III	**INDUCTION MOTOR DRIVES**	**9**

Analysis and performance of three-phase induction motor – Operation with unbalanced source voltage, single-phasing and unbalanced rotor impedance – Starting – Braking – Transient analysis – Stator voltage control –Adjustable frequency control of VSI and CSI fed induction motor – Static rotor resistance control – Slip-power recovery drives – Open loop Volts/Hz control – Principle of vector control – Vector control of induction motor – Block diagram of closed loop drive.

UNIT IV	**SYNCHRONOUS MOTOR DRIVES**	**9**

Open loop Volts/Hz control and self-control of CSI and VSI fed synchronous motor – Cycloconverter fed synchronous motor – Microprocessor based synchronous motor control – Marginal angle control and power factor control – Permanent magnet (PM) synchronous motor – vector control of PM Synchronous Motor (PMSM).

UNIT V	**BLDC, STEPPER AND SWITCHED RELUCTANCE MOTOR DRIVES**	**9**

Brushless DC motor drives and its applications – Variable reluctance and permanent magnet stepper motor Drives – Operation and control of switched reluctance motor – Applications, modern trends in industrial drive.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Bimal K. Bose, “Modern Power Electronics and AC Drives”, Pearson Education, 2002.
2. Dubey, G.K., “Fundamentals of Electrical Drives”, 2nd Edition, Narosa Publishing House,2001.

REFERENCE BOOKS:

1. Pillai, S.K., “A First Course on Electrical Drives”, Wiley Eastern Limited, 1993.
2. Krishnan, R., “Electric Motor and Drives Modelling, Analysis and Control”, Prentice Hall of India, 2001.
3. Vedam Subrahmanyam, “Electrical Drives”, Tata McGraw-hill Publishing company limited,1994.
4. Gopal K.Dubey, “Power semiconductor Controlled Drives”, Prentice Hall,1989

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/108/104/108104140/

COURSE CODE: **1152EE119**	COURSE TITLE: **PRINCIPLES OF ROBOTICS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program **Elective**

PREAMBLE :

To impart the basic concepts of robotics and their design manufacture, application, and structural disposition.

PREREQUISITE COURSES:

Microprocessor & Microcontroller

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand the basic components of robots and its sensors
- Know the basics of Control and analysis of robotics motion
- Give a brief introduction about artificial intelligence
- Write basic programming in robotics
- Familiar with the applications of robots

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Describe the basic components of robots and its sensors	K2
CO2	Explain the basics of Control and analysis of robotics motion	K2
CO3	Illustrate the basics of artificial intelligence	K2
CO4	Write basic programming in robotics	K3
CO5	Outline the applications of robots	K2

CORRELATION OF COs WITH POs AND PSOs

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		L									L	H	
CO2	H	M	L									M	H	
CO3	H		L									M	H	L
CO4	H	M	L									M	H	M
CO5	H		L										H	

COURSE CONTENT:

UNIT I	INTRODUCTION	9

Automation and robotics - Robot Anatomy - Classifications of Robots by DOF motion, platform, power source, intelligence and application area.

BASIC COMPONENS OF ROBOTS

a) Manipulators – Wrists - End effectors - Control units - Power units - Robot sensors;

b) Robot sensors - Proximity sensors - Ranger sensors - Tactile sensors - Visual sensors - Sensors for mobile Robots.

UNIT II	ROBOT MOTION ANALYSIS AND CONTROL	9

Introduction to manipulator kinematics - Homogeneous transformations and Robot kinematics - Manipulator path control - Robot dynamics - configuration of a Robot controller - Obstacle avoidance.

UNIT III	ARTIFICIAL INTELLIGENCE	9

AI –techniques – fuzzy logic, neural network - LISP programming - AI and Robotics - LIPS in the factory - Sensing and digitizing function machine vision - Image processing and analysis training and vision system - natural language processing - speech recognition - legged locomotion - collision avoidance - natural networks computing.

UNIT IV	ROBOT PROGRAMMING	9

Methods of Robot programming - lead through programming methods - a robot program as a path in space - motion interpolation - weight, signal and delay commands - Branching, capabilities and limitations of lead through methods.

UNIT V	APPLICAIONS OF ROBOT	9

Material handling - Processing operations - Assembly and inspection - Future application.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Mikell P.Groover, Michell wein,Roger N. Nagal and Nicholas G.Ordey, "Industrial Robotics, technology, Programming and applications" Mc Graw Hill, Last print, 1987.
2. Harry H. Poole, "Fundamentals of Robotics Engineering", Van Nostrand Reinhold, New York, 1989.

REFERENCE BOOKS:

1. V.Damel Hunt, "Smart Robots", Chappan and Hall, 1985
2. P.G.Ranky, C.Y.Ho, "Robot Modeling", IFS (publication) Ltd., UK., 1985.
3. Wenwar L. Hall, Bethe C. Hall, "Robotics – A user friendly introducion", Holt – Saunders International Edition, Japan, 1985.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/112/105/112105249/

COURSE CODE: **1152EE120**	COURSE TITLE: **EMBEDDED SYSTEMS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program **Elective**

PREAMBLE :

This Course aims to enable the students to gain a fair knowledge on concepts, characteristics and applications of embedded systems to Electrical Engineering and also it will make the students familiarize with real-time.

PREREQUISITE COURSES:

Microprocessor & Microcontroller.

RELATED COURSES:

Embedded System Design

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Teach students all aspects of the design and development of an embedded system, including hardware and embedded software development.
- Learn and understand the characteristics of embedded systems and its architectures.
- Understand and experience of state of – the - practice industrial embedded systems and intelligent embedded system development.
- Understand the operation of real time systems.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the definitions, components and requirements of the Embedded System.	K2
CO2	Describe the processor, architecture and memory organisation of the Embedded System.	K2
CO3	Develop the interfacing and communication techniques of the Embedded System.	K3
CO4	Explain the I/O, testing and applications of the Embedded System.	K2
CO5	Describe the definitions, characteristics and issues of real time systems and Develop the algorithm for real time applications	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		L		L								L	
CO2	H		L		L						L	L	M	L

CO3	H		M	L	L	L							M	L
CO4	H	M	H	L	L	L					M	L	M	M
CO5	H	M	M		L								M	M

COURSE CONTENT:

UNIT I	**INTRODUCTION TO EMBEDDED SYSTEMS**	**9**

Introduction to Embedded Systems - definitions and constraints; Structures - Components - Hardware and Processor Requirements - Device and Device drivers - Examples of embedded systems.

UNIT II	**EMBEDDED PROCESSORS & MEMORY**	**9**

Special Purpose Processors - General Purpose Processors - Architectural Issues: ARM, PIC, CISC, RISC, DSP Architectures - Memory - Memory Organization.

UNIT III	**EMBEDDED INTERFACING & COMMUNICATION**	**9**

Memory Interfacing - Bus, Protocols & ISA Bus Interfacing - USB Interfacing - AD/DA interfacing - Parallel Data Communication - Serial Data Communication - Network Communication - Wireless Communication.

UNIT IV	**EMBEDDED SYSTEM I/O, TESTING & APPLICATION**	**9**

Timer – Interrupts – DMA – USB & IrDA - Testing - BIST - Open-loop and Closed Loop Control Systems - Application Examples: Washing Machine, Automotive Systems, Auto-focusing digital camera, Air-conditioner, Elevator Control System, ATM System.

UNIT V	**REAL TIME EMBEDDED SYSTEM**	**9**

Introduction - Definition & characteristics of real-time systems - Issues in real time computing - Structure and performance measures of a real time system - Classical Uniprocessor scheduling algorithms - Uniprocessor scheduling of IRIS tasks - Mode changes - Fault tolerant scheduling.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Raj Kamal, “Embedded Systems”, Tata McGraw Hill, 1st Edition, 2004
2. David Simon, "An Embedded Software Primer", Addison Wesley, 2000.
3. RTS: Real-Time Systems, by C.M. Krishna and Kang G. Shin, McGraw-Hill, 1997, ISBN 0-07-057043.
4. Jean J.Labrosse, “Embedded system building blocks”, CMP books, 2nd Edition, 1999

REFERENCE BOOKS:

1. R. Mall, Real Time Systems Theory and Practice, Pearson, 2008.
2. T. Noergaard, “Embedded Systems Architecture: A Comprehensive Guide for Engineers and Programmers”, Newness 2005.
3. Dr. Prasad, “Embedded Real Time System”, Wiley Dreamtech, 2004.

ONLINE RESOURCES:

1. https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-cs22/

COURSE CODE: **1152EE121**	COURSE TITLE: **EMBEDDED CONTROL OF ELECTRICAL DRIVES**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

Application of Electronic knowledge in industry for rectification of polyphase supply voltage and controlling of motor speed, thermal heating.

PREREQUISITE COURSES:

- Microprocessor & Microcontroller

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Understand about electrical drive systems
- Acquire knowledge on ac and dc electric drives
- Know the transient and frequency response of ac and dc electric drives
- Understand the closed loop control of electrical drives
- Know the applications of microcontroller and DSP in electrical drives

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain about the basics characteristics of electrical motors.	K2
CO2	Outline the types of AC and DC electric drives and its stability considerations.	K2
CO3	Illustrate the physical representation of electrical drives to find frequency and transient response.	K2
CO4	Explain the closed loop control of electrical drives.	K2
CO5	Summarize the applications of microcontroller and DSP based control of electrical drives	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H											L	H	
CO2	H											L	H	
CO3	H	M	L									M	H	
CO4	H	M	L									M	H	
CO5	H	M	L								L	M	H	

COURSE CONTENT:		
UNIT I	**INTRODUCTION**	**9**
Electric drive systems - solid state devices - solid state switching circuits – characteristics of electric motors - speed torque characteristics of electric motors – PWM techniques - rating and heating of motors.		
UNIT II	**AC AND DC ELECTRIC DRIVES**	**9**
Introduction – classification of electric drives – dynamic conditions of a drive system – stability considerations of electrical drives – dc choppers, inverters, cycloconverter, ac voltage controllers, stepper motor.		
UNIT III	**POWER CONVERTERS**	**9**
Induction motor drives – synchronous motor drives – dc drives – block diagram representation of drive systems, signal flow graph representation of the systems, transient response, frequency response, stability of controlled drives.		
UNIT IV	**CLOSED LOOP CONTROL OF ELECTRICAL DRIVES**	**9**
Drive considerations – control system components – mathematical preliminaries – Nyquist stability criterion – Assessment of relative stability using Nyquist criterion – closed loop frequency response – sensitivity analysis in frequency domain – PID controllers – feed back compensation, robust control system design.		
UNIT V	**MICROCONTROLLERS AND DSP APPLICATIONS**	**9**
Introduction – dedicated hardware system versus microcontroller control – application areas and functions of microcontroller and dsp in drive technology – control of electric drives using microcontroller and dsp – control system design of microcontroller based variable speed drives – applications in textile mills, steel rolling mills, cranes and hoist drives, cement mills, sugar mills, machine tools, coal mills, paper mills, centrifugal pumps, turbo compressors.		
TOTAL: 45 PERIODS		
TEXT BOOKS:		
1. Vedam Subrahmanyam, “Electric drives – concepts and applications”, Tata McGraw Hill publishing company limited, New Delhi, 2003 edition. 2. John. B. Peatman, “Design with PIC Microcontrollers “, Pearson Education, Asia 2004.		
REFERENCE BOOKS:		
1. Mohammed. A. El-sharkawi, “ Fundamentals of Electrical drives”, Books/cole, Thomson learning, A division of Thomson learning lin., 2001 edition. 2. Gopal. M, “Control System Principles and Design”, Tata McGraw Hill publishing company limited, New Delhi, second edition. 3. Nagrath. I. J, Gopal. M, “Control Systems Engineering”, New age internationalpublishers, third edition.		
ONLINE RESOURCES:		
1. https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-cs22/		

COURSE CODE: **1152EE122**	COURSE TITLE: **VLSI SYSTEM & DESIGN**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Elective

PREAMBLE :

This course provides an introduction to the design and implementation of VLSI circuits for complex digital systems and the focus is on CMOS technology.

PREREQUISITE COURSES:

- Basic Electronics Engineering, Electronic Devices and Circuits

RELATED COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Know the basic silicon semiconductor technology with its physical design
- Understand the techniques of chip design using programmable devices.
- Acquire knowledge on CMOS testing
- Understand the concepts of designing VLSI subsystems
- Know the concepts of digital system using Hardware Description Language.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's taxonomy)
CO1	Explain CMOS Technology	K2
CO2	Describe CMOS Chip Design Techniques.	K2
CO3	Elaborate various CMOS testing strategies.	K2
CO4	Describe the digital design using Programmable logic devices	K2
CO5	Illustrate the digital circuits using Hardware Description Language	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M								L		L	H	L
CO2	H	M								L			H	L
CO3	H	M	M							L			H	L
CO4	H	M	M							L	L	L	H	L
CO5	H	M	M		L					L	L	L	H	L

COURSE CONTENT:

UNIT I	**CMOS TECHNOLOGY**	**9**

An Overview of silicon semiconductor technology, Basic CMOS technology: n Well, P Well,

Twin Tub and SOI process. Circuit Elements : Resistors, Capacitors, EAROM. Latch Up and Prevention. Layout Design rules, Stick Diagram, Physical Design : Basic Concepts, CAD tools. Physical Design of logic gates : inverter, NAND, NOR, Design hierarchies.

UNIT II	**CMOS CHIP DESIGN**	**9**

Logic Design with CMOS : MOSFETS as switches, Basic logic gates in CMOS and Complex logic gates. Transmission gates : Muxes and latches. CMOS chip design options : full custom ASIC'S, semi custom ASIC and programmable ASIC. Programmble logic structures : 22V10, programming PAL's, Programmable interconnect Reprogrammable GA : Xilinx programmable GA, Features and internal structure of CPLDs, FPGAs, designing with CPLDs and FPGAs. Introduction to IC floor planning and testing, ASIC Design flow.

UNIT III	**CMOS TESTING**	**9**

Need for testing , manufacturing test principles, Design strategies for test : design for testability, combinational logic testing, sequential logic testing, fault model types, ATPG, Boundary scan test, built in self test, DFT schemes. Chip level and system level test techniques.

UNIT IV	**SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES**	**9**

EPROM to realize a sequential circuit, Programmable logic devices : ROM, PLA, PAL, PLD and DESIGN, designing a synchronous sequential circuit using a GAL, realization state machine using PLD, FPGA : introduction, Switching matrix , FPGA Xilinx 2000 , Xilinx 3000.

UNIT V	**SPECIFICATION USING VERILOG HDL**	**9**

Basic concepts, language features, VLSI design flow, identifiers, arrays, instances, value set, ports, gate delays.

Types of Verilog description – structural gate level RTL, data flow RTL and structural and behavioral RTL descriptions

structural gate level RTL : Half adder , Full adder , Ripple carry adder, Multiplexer, encoder, decoder, comparator, equality detector, D-latch, D Flip Flop, JK flip flop.

Data flow RTL : Operators, Combinational logic and sequential logic examples.

structural and behavioral RTL : Delays and Timing controls ,Procedural assignments and conditional assignments, Multiplexer, Combinational logic and sequential logic examples.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Weste & E Shraghian : Principles of CMOS VLSI Design (2 / e) Addison Wesley, 1993 for Unit I to Unit I II.
2. Samir Palnitkar, Verilog HDL – Guide to digital design and synthesis, III edition , Pearson Education, 2003 for Unit V

REFERENCE BOOKS:

1. Weste & E Shraghian : Principles of CMOS VLSI Design (2 / e) Addison Wesley, 1993 for Unit I to Unit I II.
2. Samir Palnitkar, Verilog HDL – Guide to digital design and synthesis, III edition , Pearson Education, 2003 for Unit V

COURSE CODE: **1152EE142**	COURSE TITLE: **WEARABLE ELECTRONICS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

Wearable Electronics mainly deals with the fundamentals of electronics and their applications in textiles and clothing product development.

PREREQUISITE COURSES:

Basic Electronics Engineering

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Learn about fundamentals of wearable technology and different interfacing technologies
- Understand about electrostatically generated nanofibres
- Describe sensing fabric and smart fabric for health care
- Discuss the role of strain sensor in wearable devices
- Know the different applications of wearable technologies

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the basic concept of wearable technology and different interfacing methodologies.	K2
CO2	Discuss about production of nanofibres.	K2
CO3	Describe about electroactive fabrics.	K2
CO4	Outline the role of strain sensors in wearable devices.	K2
CO5	Highlight the applications of wearable technology in different fields.	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L										L	H	
CO2	H	L						L					H	
CO3	H	L						L					H	
CO4	H	L						L					H	
CO5	H	L				L	L	L					H	

COURSE CONTENT:

UNIT I	**INTRODUCTION**	**9**

Introduction - Current and Future Wearable technology - Interfacing Technologies- Communication Technologies-Data Management Technologies - Energy Management Technologies – Applications - Implications

UNIT II	**ELECTROSTATICALLY GENERATED NANOFIBRES**	**9**
Introduction - Electrospinning process-Background- Controlling the diameter of the fibre-Formation of yarns and fabrics - Electroactive nanofibers - Inherently conductive polymers and blends – Nanocomposites - Pyrolysis and coating of nanofibres		
UNIT III	**ELECTROACTIVE FABRICS AND WEARABLE MAN–MACHINE INTERFACES**	**9**
Introduction- Sensing Fabrics – Actuating fabrics- Smart Fabrics for Health care - Smart Fabric for motion capture - Smart textiles for kinesthetic interfaces.		
UNIT IV	**STRAIN SENSORS IN WEARABLE DEVICES**	**9**
Introduction - Textile Based Strain Sensors for Wearable Devices - Fabrication of Textile Based Sensors - Applications of Textile Based Strain Sensors		
UNIT V	**APPLICATIONS**	**9**
Soldiers Status Monitoring Software - Design and Development of Flexible Solar Tent - Optical fibre fabric display-Communication apparel, Protection and Safety aspects of using electronic gadgets		
	TOTAL:	**45 PERIODS**
TEXT BOOKS:		

1. Xiaoming Tao, “Wearable electronics and photonics”, CRC Press, 2005
2. Subhas C. Mukhopadhyay, “Wearable Electronics Sensors: For Safe and Healthy Living”, Springer International Publishing, 2015

COURSE CODE: **1152EE123**	COURSE TITLE: **VIRTUAL INSTRUMENTATION**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

To study the concept of virtual instrumentation using software language

PREREQUISITE COURSES:

- Measurement and Instrumentation

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Represent and review signals in digital domain
- Understand the fundamentals of virtual instrumentation
- Familiar with the standards of VI systems
- Impart the concepts of graphical programming
- Identify the analysing tools and simple programming in VI

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Represent and review signals in digital domain	K2
CO2	Describe the fundamentals of virtual instrumentation	K2
CO3	Explain about the standards of VI systems	K2
CO4	Illustrate the concepts of graphical programming	K2
CO5	Identify the analysing tools and simple programming in VI	K3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L											H	
CO2	H	L											H	
CO3	H	L											H	
CO4	H	M	L									L	H	
CO5	H	H	L		M						L	M	H	L

COURSE CONTENT:

UNIT I	**REVIEW OF DIGITAL INSTRUMENTATION**	**9**

Representation of analog signals in the digital domain – Review of quantization in amplitude and

time – Sample and hold –Sampling theorem – ADC and DAC		
UNIT II	**FUNDAMENTALS OF VIRTUAL INSTRUMENTATION**	**9**
Concept of virtual instrumentation – PC based data acquisition – Typical on board DAQ card – Resolution and sampling frequency – Multiplexing of analog inputs – Single-ended and differential inputs – Different strategies for sampling of multi-channel analog inputs – Concept of universal DAQ card – Use of timer-counter and analog outputs on the universal DAQ card		
UNIT III	**CLUSTER OF INSTRUMENTS IN VI SYSTEM**	**9**
Interfacing of external instruments to a PC – RS232 – RS 422 – RS 485 – USB standards – IEEE 488 standard – ISO-OSI model for serial bus – Introduction to bus protocols of MOD bus and CAN bus		
UNIT IV	**GRAPHICAL PROGRAMMING ENVIRONMENT IN VI**	**9**
Concepts of graphical programming – Lab-view software – Concept of VIs and sub VI – Display types – Digital – Analog – Chart – Oscilloscopic types – Loops – Case and sequence structures – Types of data – Arrays – Formulae nodes – Local and global variables – String and file I/O		
UNIT V	**ANALYSIS TOOLS AND SIMPLE APPLICATIONS IN VI**	**9**
Fourier transform – Power spectrum – Correlation – Windowing and filtering tools – Simple temperature indicator – ON/OFF controller – PID controller – CRO emulation – Simulation of a simple second order system – Generation of HTML page		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Gupta, S. and Gupta, J.P., “PC Interfacing for Data Acquisition and Process Control”, Instrument society of America, 1994.
2. Peter W. Gofton, “Understanding Serial Communications”, Sybex International, 1994.
3. Robert H. Bishop, “Learning with Lab-view”, Prentice Hall of India, 2003.

REFERENCE BOOKS:

1. Kevin James, “PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control”, Newnes, 2000.
2. Gary W. Johnson, Richard Jennings, “Lab-view Graphical Programming”, McGraw-Hill Professional Publishing, 2001.
3. Virtual Instrumentation Using Labview, JOVITHA JEROME, PHI Learning, 2010

COURSE CODE: **1152EE124**	COURSE TITLE: **DIGITAL CONTROL SYSTEMS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Elective

PREAMBLE :

This course will supplement the Control System course in Program Core by introducing the concepts of digital control system, design of compensators in discrete domain, formulating state model for discrete time system and finally providing idea about optimal control.

PREREQUISITE COURSES:

- Control Systems

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Introduce about digital control system
- Design compensators in discrete domain
- Extend the knowledge of state space to discrete time system
- Provide the basics of Optimal control and Lyapunov stability

COURSE OUTCOMES :

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

CO No	Course Outcome	Knowledge Level(Revised Blooms Taxonomy)
CO1	Explain the method conversion of continuous time to discrete time systems and the need of digital control system	K2
CO2	Apply the knowledge of Z-transforms in handling difference equations and obtaining the pulse transfer functions	K3
CO3	Design compensators via time and frequency domain methods	K4
CO4	Develop state model and check for controllability and observability of discrete time system perform a design via pole placement	K3
CO5	Apply the application of Lyapunov theorems and about optimal control for linear / non linear systems	K3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M								L	M	H	L
CO2	H	H	M								M	M	H	M
CO3	H	H	M	M							M	M	H	M
CO4	H	H	M	M							M	M	H	M
CO5	H	H	M								M	M	H	M

COURSE CONTENT:		
UNIT I	**INTRODUCTION**	**9**
Need for digital Control-Signal Conversion- Discrete Time Signals- Discrete Time system Representation- Quantizing and Quantization Error- Sampling Process-Sampling Rate selection-Aliasing-Data Reconstruction		
UNIT II	**PULSE TRANSFER FUNCTIONS**	**9**
Z- Transform-Inverse Z Transform- Difference Equation-Mapping s-Plane to z- Plane-Pulse Transfer Function- Pulse Transfer Function of Closed Loop System- Stability- Jury's Stability Test- Bilinear transformation		
UNIT III	**DESIGN OF SAMPLED DATA SYSTEM**	**9**
Root locus Method – Controller Design using root locus-Nyquist Stability Criteria-Bode Plot – Lag/Lead and Lag-Lead Compensator design in frequency domain- Design of Systems with Dead Beat- Some Practical Issues		
UNIT IV	**STATE SPACE MODEL FOR DISCRETE TIME SYSTEMS**	**9**
Introduction- State Variable representation-Conversion from state model to transfer function and vice versa- Solution of state difference equation- Concepts of Controllability and Observability-Design Via Pole Placement- State Observers		
UNIT V	**LYAPUNOV STABILITY AND OPTIMAL CONTROL**	**9**
Stability Definition-Lyapunov Stability Theorem- Lyapunov functions for linear/nonlinear system-Introduction to Optimal Control- Performance Indices- LQR design		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. "Discrete Time Control Systems" by Kautshiko Ogata, Pearson Education ,2nd edition 2015
2. "Digital Control and State Variable Methods" by M.Gopal, TMH Publication , 2nd edition, 2014

REFERENCE BOOKS:

1. "Digital Control System" by B.C Kuo,Oxford University Press, 2nd Edition, 2007
2. "Digital Control of Dynamic Systems", by G. F. Franklin, J. D. Powell and M. L. Workman,Addison Wesley, 3rd edition 2010

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/108106163

COURSE CODE: **1152EE125**	COURSE TITLE: **INTRODUCTION TO NONLINEAR DYNAMICAL SYSTEMS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Elective

PREAMBLE :

The basic necessity of this course arises from the fact that most of the real world systems are highly nonlinear and handling these needs some preliminary background of these systems and its behaviour. This course introduces Nonlinear Systems in a basic level starting from one dimensional flow and ending in two dimensional flows**.**

PREREQUISITE COURSES:

- Control Systems

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Impart knowledge about nonlinear systems in general
- Provide adequate knowledge in Bifurcation methods in 1 and 2 D flows
- Introduce the concepts of Chaos

COURSE OUTCOMES :

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

CO Nos	Course Outcomes	Knowledge Level(Revised Bloom's Taxonomy)
CO1	Illustrate the importance of nonlinear Systems	K2
CO2	Explain various bifurcations methods for 1D systems	K2
CO3	Explain various bifurcations methods for 2D systems	K2
CO4	Describe the existence of limit cycles and its implications	K2
CO5	Explain about chaotic Systems	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L											H	
CO2	H	M	L								L	L	H	
CO3	H	M	L								L	L	H	
CO4	H	M	L								L	M	H	
CO5	H	M	L								L	M	H	

COURSE CONTENT:

UNIT I	**INTRODUCTION AND ONE-DIMENSIONAL FLOW**	**9**

Introduction to Dynamics – Importance of Nonlinear Systems-1D Systems- Fixed points and Stability- Linear stability Analysis- Existence and Uniqueness- Potentials

UNIT II	**BIFURCATIONS IN 1 D SYSTEMS AND FLOWS ON CIRCLE**	**9**

Saddle Node – Transcritical – Pitch Fork –Uniform/Non uniform Oscillator-examples

UNIT III	2 D FLOWS	9
Linear Systems: Introduction – Example- Classification; Phase Plane: Introduction- Phase portraits-Existence and uniqueness-Linearization-Conservative System- Reversible System- Index Theory		
UNIT IV	**LIMIT CYCLES AND BIFURCATION IN 2D**	**9**
Introduction- Existence of Limit Cycle- Poincare Bendixson Theorem-Lienard Systems- Relaxation and Weakly Nonlinear Oscillator; Bifurcations: Saddle. Trans-critical, Pitch fork- Hopf Bifurcation-examples- Poincare Maps		
UNIT V	**INTRODUCTION TO CHAOS**	**9**
Lorenz Equation- Properties of Lorenz Equation-Chaos on Strange attractor- Lorenz Map- One dimensional Maps – Fixed Points and Cobweb – logistic map- Liapunov and Exponent.		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. "Introduction to Applied Nonlinear Dynamical Systems and Chaos" , Stephen Wiggins, 2nd Edition , Springer 2010
2. "Nonlinear Dynamics and Chaos with applications to Physics, Biology, chemistry and Engineering", Steven H Strogatz, Indian Edition by Levant Books- 2007

COURSE CODE: **1152EE126**	COURSE TITLE: **NETWORK ANALYSIS AND SYNTHESIS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

To expose basic circuit concepts, circuit modeling and methods of circuit analysis in time domain and frequency domain for solving simple and multi-dimensional circuits including coupled circuits and three phase circuits.

PREREQUISITE COURSES:

- Circuit Analysis

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Understand the concept of graph theory using different analysis methods
- Apply different network functions for the analysis of electrical networks
- Understand the concept of two port networks
- Understand the properties of network functions
- Explain about the fundamental and types of filter

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
C01	Illustrate the concept of graph theory using different analysis methods	K2
C02	Apply different network functions for the analysis of electrical networks	K3
C03	Summarize the concept of two port networks	K2
C04	Outline the properties of network functions	K2
C05	Explain about the fundamental and types of filter	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L								L	M	H	
CO2	H	H	L	L							L	M	H	L
CO3	H	M	L	L								M	H	
CO4	H	M	L									L	H	
CO5	H	M	L								L	M	H	L

COURSE CONTENT:		
UNIT I	**GRAPH THEORY**	**9**
Graph of a Network - definitions, tree, co tree , link, basic loop and basic cut set - Incidence matrix - cut set matrix - Tie set matrix Duality - Loop and Nodal methods of analysis.		
UNIT II	**NETWORK FUNCTIONS**	**9**
Concept of Complex frequency - Transform Impedances Network functions of one port and two port networks - concept of poles and zeros - properties of driving point and transfer functions - time response and stability from pole zero plot.		
UNIT III	**TWO PORT NETWORKS**	**9**
Characterization of LTI two port networks ZY - ABCD and h parameters - reciprocity and symmetry. Inter-relationships between the parameters - inter-connections of two port networks - Ladder and Lattice networks - T & Π Representation.		
UNIT IV	**NETWORK SYNTHESIS**	**9**
Positive real function - definition and properties - properties of LC, RC and RL driving point functions - synthesis of LC, RC and RL driving point immittance functions using Foster and Cauer first and second forms.		
UNIT V	**FILTERS**	**9**
Image parameters and characteristics impedance - passive filter fundamentals, low pass, high pass, band pass, band reject, (constant K type) filters,		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. M.E. Van Valkenburg, “Network Analysis”, Prentice Hall of India
2. A.Chakrabarti, “Circuit Theory” Dhanpat Rai & Co.
3. C.L Wadhwa, “Network Analysis and Synthesis” New Age International Publishers, 2007.
4. D.Roy Choudhary, “Networks and Systems” Wiley Eastern Ltd.
5. Donald E. Scott: “An Introduction to Circuit analysis: A System Approach” McGraw Hill

REFERENCE BOOKS:

1. M.E. Van Valkenburg, “An Introduction to Modern Network Synthesis”,Wiley Eastern Ltd.
2. N.C. Jagan and C. Lakshminarayana, “Newwork Analysis” B.S. Publications, 2008.
3. K.S. Suresh Kumar, “Electric Circuits and Networks” Pearson Education, 2009.
4. A Ramakalyan, “Linear Circuits: Analysis and Synthesis” Oxford University Press, 2005.
5. Mahmood Nahvi, Joseph A Edminister ”Schaum's Outline of Electric Circuits” TATA McGraw –Hill 2004

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/108105159

COURSE CODE: **1152EE127**	COURSE TITLE: **SIGNALS AND SYSTEMS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

This course becomes the basis of introducing the students to the concept of signals, systems and its types, also the method of handling the signals by various mathematical tools. This course is designed pedagogically and uncovers the concepts of continuous and discrete time signals and the systems.

PREREQUISITE COURSES:

Engineering Mathematics

RELATED COURSES:

Control Systems, Digital Signal Processing, Digital Control Systems

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Introduce signals(Continuous and discrete), systems(Continuous and discrete), its types and operation on signals
- Provide an intuitive understanding of the application of Fourier Series, Fourier Transforms(Including DFT) and Z-transforms
- Show the applications of these mathematical tools in networks

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Classify the various types of signal and systems and operate on the signals(like shifting ,scaling etc)	K2
CO2	Apply Fourier series and Fourier transforms in the analysis of signals	K3
CO3	Identify the significance of Laplace Transforms and apply the same to some basic circuits	K3
CO4	Explain the concept of sampling	K2
CO5	Apply the Z-Transforms technique to DT signal	K3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L								L	M	H	L
CO2	H	M	M	L							L	M	H	L
CO3	H	M	M	L							L	M	H	L
CO4	H	M	L								L	M	H	L
CO5	H	M	M								L	M	H	L

COURSE CONTENT:		
UNIT I	**CLASSIFICATION OF SIGNALS AND SYSTEMS**	**9**
Introduction to Continuous and Discrete Time Signals- Continuous to Discrete transformation-sampling-Classifications of Continuous and Discrete time signal-Introduction to Continuous and Discrete Time systems and its Classification- LTI System- Impulse response		
UNIT II	**FOURIER SERIES ANALYSIS**	**9**
Introduction to Fourier Series-Trigonometric Coefficients- Evaluation of Fourier Coefficients - Symmetry Conditions – Discrete time Fourier Series-Application of Fourier Series to networks		
UNIT III	**FOURIER TRANSFORMS**	**9**
Representation of a periodic signals- Continuous time Fourier Transform - Proper ties of Fourier Transforms-Discrete Time Fourier Transforms - Properties of DTFT-Duality- Fourier Series and Transform Pairs		
UNIT IV	**LAPLACE TRANSFORMS**	**9**
Fourier to Laplace and Motivation-Region of Convergence - Properties of Laplace transforms-Inverse Laplace Transforms- Application to Circuits		
UNIT V	**Z- TRANSFORMS**	**9**
Introduction-Region of Convergence- Relation Between s and z Plane- Z-transform Pairs-Application of Z-transforms to Discrete time systems-		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. B. P. Lathi, “Principles of Linear Systems and Signals”, Second Edition, Oxford, 2009.
2. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, “Signals and Systems”, Pearson, 2007.

REFERENCE BOOKS:

1. R.E.Zeimer, W.H.Tranter and R.D.Fannin, “Signals & Systems - Continuous and Discrete”, Pearson, 2007.
2. John Alan Stuller, “An Introduction to Signals and Systems”, Thomson, 2007.
3. M.J.Roberts, “Signals & Systems Analysis using Transform Methods & MATLAB”, Tata McGraw Hill, 2007.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/108106163

COURSE CODE: **1152EE128**	COURSE TITLE: **SOFT COMPUTING**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Elective

PREAMBLE :

This course becomes the basis of introducing the students to the concept soft computing techniques like neural network, fuzzy logic, genetic algorithm and hybrid soft computing techniques.

PREREQUISITE COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Understand about the basics of soft computing techniques like neural network, fuzzy logic, genetic algorithm and hybrid soft computing techniques with its applications.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the basics of soft computing techniques	K2
CO2	Describe the neural network concepts	K2
CO3	Explain about the fuzzy logic concepts	K2
CO4	Illustrate the basic concepts of genetic algorithm	K2
CO5	Describe about hybrid soft computing techniques and its applications	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L								L	M	H	L
CO2	H	M	M								L	M	H	L
CO3	H	M	M								L	M	H	L
CO4	H	M	M								L	M	H	L
CO5	H	M	M								L	M	H	L

COURSE CONTENT:

UNIT I	**INTRODUCTION**	**9**

Artificial neural network: Introduction, characteristics- learning methods – taxonomy – Evolution of neural networks- basic models – important technologies – applications. Fuzzy logic: Introduction – crisp sets- fuzzy sets – crisp relations and fuzzy relations: cartesian product of relation – classical relation, fuzzy relations, tolerance and equivalence relations, non-iterative fuzzy sets. Genetic algorithm- Introduction – biological background – traditional optimization and search techniques – Genetic basic concepts.

UNIT II	**NEURAL NETWORKS**	**9**

McCulloch-Pitts neuron – linear separability – hebb network – supervised learning network: perceptron networks – adaptive linear neuron, multiple adaptive linear neuron, BPN, RBF,

TDNN- associative memory network: auto-associative memory network, hetero-associative memory network, BAM, hopfield networks, iterative autoassociative memory network & iterative associative memory network – unsupervised learning networks: Kohonen self organizing feature maps, LVQ – CP networks, ART network.

UNIT III	**FUZZY LOGIC**	**9**

Membership functions: features, fuzzification, methods of membership value assignments-Defuzzification: lambda cuts – methods – fuzzy arithmetic and fuzzy measures: fuzzy arithmetic – extension principle – fuzzy measures – measures of fuzziness -fuzzy integrals – fuzzy rule base and approximate reasoning : truth values and tables, fuzzy propositions, formation of rules-decomposition of rules, aggregation of fuzzy rules, fuzzy reasoning-fuzzy inference systems-overview of fuzzy expert system-fuzzy decision making.

UNIT IV	**GENETIC ALGORITHM**	**9**

Genetic algorithm and search space – general genetic algorithm – operators – Generational cycle – stopping condition – constraints – classification genetic programming – multilevel optimization – real life problem- advances in GA.

UNIT V	**HYBRID SOFT COMPUTING TECHNIQUES & APPLICATIONS**	**9**

Neuro-fuzzy hybrid systems – genetic neuro hybrid systems – genetic fuzzy hybrid and fuzzy genetic hybrid systems – simplified fuzzy ARTMAP – Applications: A fusion approach of multispectral images with SAR, optimization of traveling salesman problem using genetic algorithm approach, soft computing based hybrid fuzzy controllers.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. J.S.R.Jang, C.T. Sun and E.Mizutani, “Neuro-Fuzzy and Soft Computing”, PHI / Pearson Education 2004.
2. S.N.Sivanandam and S.N.Deepa, “Principles of Soft Computing”, Wiley India Pvt Ltd, 2011.

REFERENCE BOOKS:

1. S.Rajasekaran and G.A.Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis & Applications”, Prentice-Hall of India Pvt. Ltd., 2006.
2. George J. Klir, Ute St. Clair, Bo Yuan, “Fuzzy Set Theory: Foundations and Applications” Prentice Hall, 1997.
3. David E. Goldberg, “Genetic Algorithm in Search Optimization and Machine Learning” Pearson Education India, 2013.
4. James A. Freeman, David M. Skapura, “Neural Networks Algorithms, Applications, and Programming Techniques, Pearson Education India, 1991.
5. Simon Haykin, “Neural Networks Comprehensive Foundation” Second Edition, Pearson Education, 2005.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/106105173

COURSE CODE: **1152EE129**	COURSE TITLE: **BIO MEDICAL INSTRUMENTATION**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Elective

PREAMBLE:

The course is designed to make the student acquire an adequate knowledge of the physiological systems of the human body and relate them to the parameters that have clinical importance. The fundamental principles of equipment that are actually in use at the present day are introduced.

PREREQUISITE COURSES: Basic Electrical Engineering

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Provide an acquaintance of the physiology of the heart, lung, blood circulation and circulation respiration.
- Introduce the methods of different transducers used.
- Provide the latest ideas on devices of non-electrical devices.
- Provide latest knowledge of Pulmonary Measurement & Bio Telemetry
- Bring out the important and modern methods of imaging techniques.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain about the fundamentals of biomedical engineering	K2
CO2	Explain about the basics of various sensing and measurement devices	K2
CO3	Illustrate the latest ideas on devices of non-electrical devices	K2
CO4	Apply the latest knowledge of Pulmonary Measurement & Bio Telemetry	K3
CO5	Describe about the modern methods of imaging techniques and biometric system	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L										L	M	
CO2	H	L										L	M	
CO3	H	L	L								L	L	M	L
CO4	H	L										L	M	
CO5	H	L	L								L	L	M	L

COURSE CONTENT:		
UNIT I	**FUNDAMENTALS OF BIOMEDICAL ENGINEERING**	**9**
Cell and its structure – Resting and Action Potential – Nervous system – Basic components of a biomedical system- Cardiovascular systems- Respiratory systems - Biomechanics of soft tissues - Basic mechanics of spinal column and limbs- Transducers – selection criteria – Piezo electric, ultrasonic transducers - Temperature measurements - Fibre optic temperature sensors.		
UNIT II	**BIOMEDICAL MEASUREMENT**	**9**
Electrodes –types-Amplifiers - ECG – EEG – EMG – ERG - Electrical safety in medical environment, shock hazards – leakage current-Instruments for checking safety parameters of biomedical equipments.		
UNIT III	**NON ELECTRICAL PARAMETERS MEASUREMENT AND DIAGNOSTIC PROCEDURES**	**9**
Measurement of blood pressure - Cardiac output - Heart rate - Heart sound - Pulmonary function measurements – spirometer – Photo Plethysmography, Body Plethysmography – Blood Gas analysers, pH of blood –measurement of blood pCO2, pO2, finger-tip oxymeter - ESR, GSR measurements.		
UNIT IV	**PULMONARY MEASUREMENT AND BIO TELEMETRY**	**9**
Physiology of respiratory system – Respiratory rate measurement – wire and wireless Biotelemetry – Telemetering multiple information – implanted transmitters – causes of electrical hazards and safety techniques.		
UNIT V	**MEDICAL IMAGING SYSTEM**	**9**
Ultrasound scanner – Echo cardiography – Coloar Doppler system – CAT and CT scan – MRI Imaging – Cine angiogram – LASER Imaging – Endoscope.		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Leslie Cromwell, Biomedical Instrumentation and Measurement, Prentice hall of India, New Delhi,2007.
2. Joseph J.carr and John M. Brown, Introduction to Biomedical Equipment Technology, John Wileyand sons, New York, 4th Edition, 2012.
3. Khandpur R.S, Handbook of Biomedical Instrumentation, , Tata McGraw-Hill, New Delhi, 2nd Edition, 2003.

REFERENCE BOOKS:

1. John G. Webster, Medical Instrumentation Application and Design, John Wiley and sons, NewYork, 1998.
2. Duane Knudson, Fundamentals of Biomechanics, Springer, 2nd Edition, 2007.
3. Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Health Care Systems, Technology and Techniques, Springer, 1st Edition, 2011.

ONLINE RESOURCE:

1. https://nptel.ac.in/courses/102106098

COURSE CODE: **1152EE130**	COURSE TITLE: **PROCESS AUTOMATION**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

This course is designed to provide the knowledge on recent trends in automation techniques (Programmable Logic Controllers & Distributed Control Systems deployed in the various core industries and research organization.

PREREQUISITE COURSES:

Digital Logic Circuits

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Realize the working, design and need of timers, counters, various memories and their efficient managing techniques.
- Relate the automation techniques to real world engineering applications.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Illustrate the basics of PLCs	K2
CO2	Design Ladder Diagram by programming the timers and counters.	K3
CO3	Design the PLCs addressing applications and research problems.	K3
CO4	Exemplify the basics and design of DCS	K3
CO5	Integrating various components to DCS to execute Automation	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	M	M							L	M	H	L
CO2	H	H	M	H								L	H	
CO3	H	L	L	M								L	H	L
CO4	H	L	M	M							L	M	H	L
CO5	H	M	L									L	H	

COURSE CONTENT:

UNIT I	**PROGRAMMABLE LOGIC CONTROLLER**	**9**

Evolution of PLC's – Components of PLC – Advantages over relay logic - PLC programming

languages		
UNIT II	**PROGRAMING IN PLC**	**9**
Ladder diagram – Programming timers and counters – Design of PLC.		
UNIT III	**APPLICATIONS OF PLC**	**9**
Instructions in PLC – Program control instructions, math instructions, sequencer instructions – Use of PC as PLC – Application of PLC – Case study of bottle filling system		
UNIT IV	**DISTRIBUTED CONTROL SYSTEMS (DCS)**	**9**
Definition, architecture (centralized, hybrid generalized DCS) Local Control Unit (LCU) architecture, LCU languages, LCU – Process interfacing issues, communication facilities, configuration of DCS.		
UNIT V	**INTERFACES IN DCS**	**9**
Operator interfaces - Low level and high level operator interfaces – Operator displays - Engineering interfaces – Low level and high level engineering interfaces – General purpose computers in DCS.		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Programmable Logic Controllers, 3rd Edition, by Frank Petruzella, Tata Mc Grawhill publications.

REFERENCE BOOKS:

1. Programmable Logic Controllers, 5th Edition, by George Bolton, Elsevier India publications.
2. Programmable Logic Controllers, by Webb John W, Reis Ronald A, PHI learning pvt ltd.
3. Programmable Logic Controllers: Programming methods and Applications 1st Edition by Hackworth, Pearson India Publications.

COURSE CODE: **1152EE132**	COURSE TITLE: **UTILIZATION OF ELECTRICAL ENERGY**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

This course will provide knowledge on illumination of lighting, Traction, Electrical heating, Electro mechanical energy conversion and various electrical loads.

PREREQUISITE COURSES:

- Basic Electrical Engineering

RELATED COURSES:

Product Development & Design, LED Lighting Technology

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Introduce various methods of effectively and efficiently utilizing Electrical Energy for different and desired applications
- Teach the various Electrical Lighting principles and their applications.
- Impart knowledge on effective utilization of Electrical Drives, Electrical Traction and Electro Mechanical process

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's taxonomy)
C01	Determine of MHCP and MSCP of various lighting system.	K2
C02	Illustrate the Electric Heating, Welding & Furnace process	K2
C03	Select the drives based on application, Calculation of Power Requirement for motor load utilization.	K2
C04	Illustrate the role and requirement of electrical energy in traction application.	K2
C05	Explain the Electro Mechanical Process and Calculation of Energy Requirements	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L								L	M	H	
CO2	H	M										M	H	
CO3	H	M	L								L	M	H	
CO4	H	M	L								L	M	H	
CO5	H	M										M	H	

COURSE CONTENT:		
UNIT I	**ILLUMINATION**	**9**
Production of light – Determination of MHCP and MSCP – Polar curves of different types of sources – Rousseau's construction – Lighting schemes and calculations – Factory lighting – Flood lighting – Electric lamps – Gaseous discharge – High pressure and low pressure.		
UNIT II	**ELECTRIC HEATING AND WELDING**	**9**
Resistance, Inductance and Arc furnaces – Construction and fields of application – Losses in oven and efficiency - High frequency - Dielectric heating – Characteristics of carbon and metallic arc welding – butt welding – spot welding.		
UNIT III	**ELECTRIC DRIVES AND CONTROL**	**9**
Group drive – Individual drive – selection of motors – starting and running characteristics– Running characteristics - Mechanical features of electric motors – Drives for different industrial applications - Choice of drives – power requirement calculation – power factor improvement.		
UNIT IV	**ELECTRIC TRACTION**	**9**
Traction system – Speed time characteristics – Series and parallel control of D.C motors -Open circuited, shunt and bridge transitions – Tractive effort calculation – Electric braking – Tramways and trolley bus – A.C traction and recent trend - Magnetic devitation		
UNIT V	**ELECTROMECANICAL PROCESSES**	**9**
Electrolysis – polarization factor – preparation work for Electro plating – Tanks and other equipments – Calculation of energy requirements – Methods of charging and maintenance – Ni-iron and Ni- cadmium batteries –Lead acid batteries ,Components and materials – Chemical reactions – Capacity rating of batteries – Battery charges.		
TOTAL: 45 PERIODS		

TEXT BOOKS:

1. Uppal S.L, "Electric Power", Khanna Publishers, 1988
2. Open Shaw Taylor, "Utilization of Electrical Energy", Oriented Longmans Limited (Revised in SI Units), 1971.
3. Soni A. Chakrabarti, M.L.Soni, P.V.Gupta, U.S.Bhatnagar, " A text book on Power System Enggineering", Khanna Publishers, 2000.
4. A.I.Starr, "Generation, Transmission and Utilization of Electric Power", ELBS, 1978.

REFERENCE BOOKS:

1. PSCAD User Manual.
2. Power Quality in Electrical Systems - Alexander Kusko ,McGraw-Hill Professional

COURSE CODE: **1152EE133**	COURSE TITLE: **ENERGY AUDITING AND MANAGEMENT**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Understand the concept of energy auditing and its importance
- Acquire knowledge on finance management
- Understand the importance of energy efficient electrical system

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's taxonomy)
CO1	Describe energy scenario nationwide and worldwide	K2
CO2	Outline the energy management and audit methods	K2
CO3	Summarize financial management and Energy performance contracts	K2
CO4	Explain energy related aspects of electrical system	K2
CO5	Illustrate studies related to operational aspects of compressed air system	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H					L		L					H	L
CO2	H	H	M			M			L		L	L	H	L
CO3	H	H				M			L		L	L	H	L
CO4	H	H	M			M	L						H	L
CO5	H	H	M			M	L						H	L

COURSE CONTENT:

UNIT I	**ENERGY SCENARIO**	**9**

Energy scenario of growing economy, Energy pricing, Energy sector reforms, Energy and environment, Energy security, Energy conservation and its importance, Energy conservation Act-2001 and its features

UNIT II	**ENERGY MANAGEMENT AND AUDIT**	**9**

Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to

requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments

Material and Energy Balance: Methods for preparing process flow, Material and energy balance diagrams.

UNIT III	FINANCIAL MANAGEMENT	9

Investment-need, Appraisal and criteria, Financial analysis techniques- Risk and sensitivity analysis, Financing options, Energy performance contracts and role of ESCOs.

UNIT IV	ELECTRICAL SYSTEM	9

Electricity tariff, Load management and maximum demand control, T&D losses. Losses and efficiency in induction motors, Factors affecting motor performance and remedial solutions, energy efficient motors. Light source, Choice of lighting, Luminance requirements, and Energy conservation avenues

UNIT V	COMPRESSED AIR SYSTEM	9

Types of air compressors, Compressor efficiency, Efficient compressor operation, Compressed air system components, Capacity assessment.

HVAC and Refrigeration System: Vapour compression refrigeration cycle, Coefficient of performance, Capacity, performance and savings opportunities, Vapour absorption refrigeration system: Working principle, Saving potential, Fans, Blowers and pumps- Types, Performance evaluation, Flow control strategies and energy conservation opportunities.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Abbi, Y.P. and Jain, S., Handbook on Energy Audit and Environment Management, Teri Bookstore (2006).
2. Diwan, P., Energy Conservation, Pentagon Press (2008).

REFERENCE BOOKS:

1. Younger, W., Handbook of Energy Audits, CRC Press (2008).

COURSE CODE: **1152EE134**	COURSE TITLE: **ELECTRICAL SAFETY AND QUALITY MANAGEMENT**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

To study the basic concepts of electrical safety and regulations

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- To study the electrical safety rules, regulations and quality management by the power factor improvement.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain Indian electricity rules and acts and their significance	K2
CO2	Illustrate the need of electrical safety in different locations	K2
CO3	Outline the need of electrical safety during installation of equipment's	K2
CO4	Explain the necessity of electrical safety in Hazardous zones	K2
CO5	Describe the electrical safety in distributed systems	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L			M		M			L	M	H	
CO2	H	M	L			M		L				L	H	
CO3	H	M	L			M					L	L	H	
CO4	H	M	L			M		L			L	L	H	
CO5	H	M	L			M						L	H	

COURSE CONTENT:

UNIT I	INDIAN ELECTRICITY RULES AND ACTS AND THEIR SIGNIFICANCE	9

Objective and scope – ground clearances and section clearances – standards on electrical safety - safe limits of current, voltage – earthing of system neutral – Rules regarding first aid and fire fighting facility.

UNIT II	**ELECTRICAL SAFETY IN RESIDENTIAL, COMMERCIAL AND AGRICULTURAL INSTALLATIONS**	**9**
Wiring and fitting – Domestic appliances – water tap giving shock – shock from wet wall – fan firing shock – multi-storied building – Temporary installations – Agricultural pump installation – Do's and Don'ts for safety in the use of domestic electrical appliances.		
UNIT III	**SAFETY DURING INSTALLATION, TESTING AND COMMISSIONING, OPERATION AND MAINTENANCE**	**9**
Preliminary preparations – safe sequence – risk of plant and equipment – safety documentation – field quality and safety - personal protective equipment – safety clearance notice – safety precautions – safeguards for operators – safety		
UNIT IV	**ELECTRICAL SAFETY IN HAZARDOUS AREAS**	**9**
Hazardous zones – class 0,1 and 2 – spark, flashovers and corona discharge and functional requirements – Specifications of electrical plants, equipments for hazardous locations – Classification of equipment enclosure for various hazardous gases and vapours – classification of equipment/enclosure for hazardous locations.		
UNIT V	**ELECTRICAL SAFETY IN DISTRIBUTION SYSTEM**	**9**
Total quality control and management – Importance of high load factor – Disadvantages of low power factor – Causes of low P.F. – power factor improvement – equipments – Importance of P.F. improvement		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Rao, S. and Saluja, H.L., "Electrical Safety, Fire Safety Engineering and Safety Management", Khanna Publishers, 1988.
2. Pradeep Chaturvedi, "Energy Management Policy, Planning and Utilization", Concept Publishing Company, 1997

REFERENCE BOOKS:

1. Nagrath, I.J. and Kothari, D.P., "Power System Engineering", Tata McGraw Hill, 1998.
2. Gupta, B.R., "Power System Analysis and Design", S.Chand and Sons, 2003.
3. Wadhwa, C.L., "Electric Power Systems", New Age International, 2004

COURSE CODE: **1152EE135**	COURSE TITLE: **RENEWABLE ENERGY SOURCES**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

This course focuses on the new renewable energy based electric energy generation technologies and their integration into the power grid. The principals of new energy based distributed generation technologies: solar, wind, and fuel cells.

PREREQUISITE COURSES:

Basic Electrical Engineering

RELATED COURSES:

Project work.

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Introduce about the renewable energy sources like wind, solar and wave energy.
- Impart knowledge about the environmental friendly energy production and consumption.
- Explain about energy-efficient systems and products for various applications.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain about Renewable Energy resources and importance.	K2
CO2	Outline the process of photovoltaic power generation.	K2
CO3	Outline the process of power generation using wind energy sources.	K2
CO4	Describe the biomass and biogas production techniques.	K2
CO5	Explain the fundamentals and applications of Geothermal energy, tidal energy, MHD and fuel cells.	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	M								M	M	H	
CO2	H	M	M								M	M	H	L
CO3	H	M	M								L	L	H	L
CO4	H	M	M									L	H	L
CO5	H	M	M									L	H	L

COURSE CONTENT:		
UNIT I	**INTRODUCTION**	**9**
World energy use-reserves of energy resources-energy cycle of the earth-environmental aspects of energy utilization-renewable energy resources and their importance.		
UNIT II	**SOLAR ENERGY**	**9**
Basic concepts, solar thermal systems and solar ponds, solar thermal central receiver systems, heliostats, heat transport system, thermal storage systems, photovoltaic energy conversion, solid - state principles, semi- conductors, solar cell, batteries, satellite solar power systems.		
UNIT III	**WIND ENERGY**	**9**
Principles of wind power, wind turbine operation, site characteristics, horizontal and vertical axis types, new developments, small and large machines, magnus effect, design principles of wind turbine, storage systems.		
UNIT IV	**BIOMASS AND BIOGAS**	**9**
Concepts and systems, biomass production, energy plantation, short rotation species, forestry system, biomass resource agro forestry wastes, municipal solid wastes and agro processing industrial residues, environmental factors and biomass energy development, combustion, pyrolysis, gasification and liquefaction, modeling, appliances and latest development, bioconversion: biogas, fermentation and wet processes, chemicals from biomass and biotechnology.		
UNIT V	**OTHER RENEWABLE ENERGY SOURCES**	**9**
Geothermal energy, types, systems and application, Ocean thermal energy, types, systems and applications. Wave energy - types, systems and applications. Tidal energy - types, systems and applications. Magneto Hydrodynamic system (MHD). Fuel cells – types and applications, hydrogen technologies. Micro-hydel systems. Hybrid systems and applications		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Rai G D, "Non Conventional Sources Of Energy", Khanna Publishers, 2006.

REFERENCE BOOKS:

1. Kothari P, K C Singal and Rakesh Ranjan, “Renewable Energy Sources and Emerging Technologies”, PHI Pvt. Ltd., New Delhi, 2008.
2. Sukhatme S P and Nayak J K, “Solar Energy - Principles of Thermal Collection and Storage”, Tata McGraw Hill, 2008.
3. Frank Kreith and Yogi Goswami D, “Handbook of Energy Efficiency and Renewable Energy”, CRC Press, 2007.
4. Bent Sorensen, “Renewable Energy”, Academic Press, 2004.
5. Abbasi S A and Naseema Abbasi, “Renewable Energy Sources and their Environmental Impact”, PHI Private Limited, 2001.

COURSE CODE: **1152EE136**	COURSE TITLE: **SOLAR ELECTRIC SYSTEMS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Elective

PREAMBLE :

This course helps to understand Solar Cells and Its Technologies, Photovoltaic Principles Fabrication Technology

PREREQUISITE COURSES:

Basic Electrical Engineering

RELATED COURSES:

Project work.

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Introduce about the renewable energy sources like wind, solar and wave energy.
- Impart knowledge about the environmental friendly energy production and consumption.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain about solar energy and its technologies	K2
CO2	Outline the photovoltaic principles	K2
CO3	Explain the solar cell fabrication technology	K2
CO4	Predict the performance of solar array system	K2
CO5	Summarize the applications of solar photovoltaic system	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L								L	M	H	
CO2	H	M	L								L	M	H	L
CO3	H	M	L								L	M	H	L
CO4	H	M	L								M	M	H	L
CO5	H	L	L								L	M	H	L

COURSE CONTENT:

UNIT I	**SOLAR CELLS AND ITS TECHNOLOGIES**	**9**

solar cells: working of solar cells, I-V characteristics, conversion efficiency, losses in solar cells, high efficiency solar cells, quantum dots, multi junction solar cells.

Solar cell technologies: Material selection, solar cell fabrication, amorphous, single and poly crystalline silicon solar cells, thin film solar cells, organic solar cells, first-, second- and third-generation solar cells, advantages, drawbacks, latest developments; concentrated PV systems. Testing, standardization and evaluation of solar cells.

UNIT II	**PHOTOVOLTAIC PRINCIPLES**	**9**

Solar Cell Physics: p-n junction: homo and heterojunctions, Metal-semiconductor interface; The Photovoltaic Effect, Equivalent Circuit of the Solar Cell, Analysis of PV Cells: Dark and illumination characteristics; Figure of merits of solar cell; Efficiency limits; Variation of efficiency with band-gap and temperature; Efficiency measurements; High efficiency cells, Types of Solar cells.

UNIT III	**SOLAR CELL FABRICATION TECHNOLOGY**	**9**

Preparation of metallurgical, electronic and solar grade Silicon; Production of single crystal Silicon: Czokralski (CZ) and Float Zone (FZ) method: Procedure of masking, photolithography and etching; Design of a complete silicon, GaAs, InP solar cell; High efficiency III-V, II-VI multi-junction solar cell; a-Si-H based solar cells; Quantum well solar cell, Thermo-photovoltaics.

UNIT IV	**SOLAR PHOTOVOLTAIC SYSTEM DESIGN**	**9**

Solar cell array system analysis and performance prediction; Shadow analysis: Reliability; Solar cell array design concepts; PV system design; Design process and optimization; Detailed array design; Storage autonomy; Voltage regulation; Maximum tracking; Use of computers in array design; Quick sizing method; Array protection and trouble shooting.

UNIT V	**SPV APPLICATIONS**	**9**

Centralized and decentralized SPV systems; Stand alone, hybrid and, grid connected system, System installation, operation and maintenances; Field experience; PV market analysis and economics of SPV systems. The Recent developments in Solar cells, Role of nano-technology in Solar cell. Solar thermal electric system. Lighting, refrigeration, telecommunications, aerospace, agriculture, fencing, water purification, navigation, defence, offshore, etc.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Renewable Energy Engineering and Technology – A Knowledge Compendium, ed. VVN Kishore ,TERI Press, 2008.
2. CS Solanki: Solar Photovotaics – Fundamentals, Technologies and Applications, PHI Learning, Kindle Edition - Jul 21, 2011

REFERENCE BOOKS:

1. SM Sze, Kwok K Ng: Physics of semiconductor devices, 3rd Edition, John Wiley & Sons, 2007.
2. MA Green: Solar Cells Operating Principles, Technology, and System Applications, Prentice-Hall,1981
3. MA Green: High Efficiency Silicon Solar Cells, Trans Tech Publications.
4. SJ Fonash: Solar Cell Device Physics, Academic Press, 1982.
5. Handbook of photovoltaic science and engineering, ed. Antonio Luque and Steven Hegedus , John Wiley and Sons.
6. Anna Mani, S Rangarajan: Handbook of Solar Radiation Data for India, 1980 Allied Publishers, 1980.

ONLINE RESOURCES: https://nptel.ac.in/courses/113104084

COURSE CODE: **1152EE137**	COURSE TITLE: **WIND ENERGY CONVERSION SYSTEMS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Elective

PREAMBLE :

Wind energy is the fast-growing renewable source for electricity generation. This course presents a broad overview of wind energy technology.

PREREQUISITE COURSES:

Basic Electrical Engineering

RELATED COURSES:

Renewable Energy sources, Electrical Machine Design

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Know about Power extraction from wind energy
- Understand the components and design of wind tower
- Understand working principle of induction generator, synchronous generator

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the fundamentals of wind energy conversion and measurements.	K2
CO2	Summarize the types of wind turbines and aerodynamics.	K2
CO3	Explain the basic components of wind turbine and its construction.	K2
CO4	Illustrate the power management and grid monitoring unit.	K2
CO5	Explain the Operation & Maintenance for product lifecycle.	K2

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H									L	L	H	L
CO2	H	H									L	L	H	L
CO3	H	H									L	L	H	L
CO4	H	H									L	L	H	L
CO5	H	H									L	L	H	L

COURSE CONTENT:		
UNIT I	**WIND ENERGY FUNDAMENTALS AND MEASUREMENTS**	**9**
Wind energy basics - Wind speed and scales - Terrain-Roughness-Wind mechanics - Power content – Class of wind turbine- Atmospheric boundary layers-Turbulence. Instrumentation for wind measurements - Wind data analysis - tabulation. Wind resource estimation - Betz's limit-Turbulence analysis.		
UNIT II	**WIND TURBINE AREODYNAMICS AND TYPES**	**9**
Airfoil terminology - Blade element theory - Blade design - Rotor performance and dynamics-Balancing technique (Rotor &Blade)-Types of loads - Source of loads-Vertical axis type -Horizontal axis - Constant speed Constant frequency - Variable speed variable frequency - Up wind-Down wind - Stall control-Pitch control - Gear coupled generator type - Direct generator drive/PMG/Rotor excited sync generator.		
UNIT III	**GEAR COUPLED GENERATOR WIND TURBINE COMPONENTS AND THEIR CONSTRUCTION**	**9**
Electronics sensors /Encode /Resolvers - Wind measurement: anemometer & wind vane - Grid synchronisation system - Soft starter - Switchgear [ACB/VCB]-Transformer - Cables and assembly - Compensation panel - Programmable logic control – UPS - Yaw & pitch system: AC drives - Safety chain circuits - Generator rotor resistor controller(Flexi slip) - Differential protection relay for generator - Battery/Super capacitor charger & Batteries/Super capacitor for pitch system-Transient Suppressor/Lightning arrestors - Oscillation & Vibration sensing.		
UNIT IV	**DIRECT ROTOR COUPLED GENERATOR (MULTIPOLE)[VARIABLE SPEED –VARIABLE FREQUENCY**	**9**
Excited rotor synch. Generator/PMG generator - Control rectifier-Capacitor banks - Step up/Boost converter (DC-DC Step Up) - Grid tied inverter - Power management - Grid monitoring unit (Voltage and current) - Transformer - Safety chain circuits.		
UNIT V	**MODERN WIND TURBINE CONTROL & MONITORING SYSTEM**	**9**
Details of pitch system &Control algorithms-Protections used & Safety consideration in wind turbine-Wind turbine monitoring with error codes - SCADA & Databases: remote monitoring and generation reports - Operation & Maintenance for product lifecycle - Balancing technique (Rotor & Blade) - FACTS control & LVRT & New trends for new grid codes.		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Renewable Energy Engineering and Technology – A Knowledge Compendium, ed.VVN Kishore, TERI Press, 2008.
2. Martin OL Hansen: Aerodynamics of Wind Turbines, 2nd ed. Earthscan, London
3. Anna Mani: Wind Energy Data for India, Allied Publishers, 1990.
4. C-Wet: Wind Energy Resources Survey in India Vol. VII
5. S.Rangrajan: Wind Energy Resources Survey in India V, Allied Publishers, Mumbai 1998.

6. Sathyajith Mathew: Wind Energy: fundamentals, resource analysis and economics
7. Prepared by WISE: Wind Power in India, 5000MW BY 2015
8. B.H.Khan: Non Conventional Energy Sources, Tata McGraw-Hill Education, 2006.

REFERENCE BOOKS:

1. Johnson, G.L., Wind Energy Systems, Prentice Hall, 1985.Martin OL Hansen: Aerodynamics of Wind Turbines, 2nd ed. Earthscan, London
2. Paul Gipe: “Wind energy Basics: A guide to small and micro wind” ,Chelsea Green Publishing, 2008.
3. L. L. Freris, Wind Energy Conversion systems, Prentice Hall, UK, 1990.
4. Godfrey Boyle., Renewable Energy: Power for a Sustainable Future, Second Edition, Oxford University Press, 2004.

COURSE CODE: **1152EE146**	COURSE TITLE: **GENERATION PLANNING**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE :

It is aimed to provide the basics of power system planning, particularly on generation capacity expansion planning and provide the information about the impact of environmental pollution, reliability on integration of demand and supply side management activities in addition renewable energy sources penetration.

PREREQUISITE COURSES:

Power System Analysis

RELATED COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand the load forecasting techniques, power generation reliability indices
- Know the basic concepts of generation expansion planning and WASP-IV module
- Compare the demand side and supply side management in GEP studies and the effect of penetration of renewable energy resources in power system

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Interpret the load forecasting techniques	K2
CO2	Explain types of reliability indices for power generation system	K2
CO3	Illustrate the basic concept of GEP problem	K2
CO4	Solve the effect of DSM and SSM activities in GEP	K3
CO5	Identify the impact of renewable energy on environmental pollution and reliability of power system	K3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M		L								L	H	L
CO2	H	H		M									H	L
CO3	H	L		L	M						L	L	H	L
CO4	H	L	M	M	M						L		H	L
CO5	H	L	M	M	M		M				L	L	H	L

COURSE CONTENT:

UNIT I	**LOAD FORECASTING**	**9**

Power system planning- Objective- Stages in planning and design - need for accurate load forecasting - factors affecting forecasting- approaches- methodology- Short-run and long run- Time series techniques-Peak demand and Energy forecasting

UNIT II	**POWER GENERATION RELIABILITY**	**9**

Static Generating Capacity Reliability Evaluation- Outage definitions-reliability indices- loss of load probability (LOLP) - expected energy not served (EENS) - capacity outage probability table (COPT) - simple problems.

UNIT III	**GENERATION COST OPTIMIZATION**	**9**

Definition-Formulation of least cost optimization problem- capital, operation and maintenance costs - candidate units - different types- Wien Automatic System Planning- IV (WASP-IV) model- WASP-IV modules-simple simulation studies

UNIT IV	**DEMAND SIDE MANAGEMENT (DSM) AND SUPPLY SIDE MANAGEMENT (SSM)**	**9**

DSM –Introduction- driving factors- benefits- DSM measures-Energy reduction programmes - Load management programmes - Load growth and conservation programmes - challenges of implementing DSM programmes

SSM –Introduction-options and opportunities - constraints and challenges - integration of DSM and SSM in generation planning

UNIT V	**GENERATION PLANNING WITH RENEWABLE ENERGY**	**9**

Benefits of renewable energy sources- Modelling of wind and solar plants in planning studies- negative load modelling- environmental analysis and reliability analysis.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Sullivan, R. L. *Power system planning* McGraw-Hill New York, 1977
2. James McDonald, Wang Xifan, Modern power system planning, McGraw-Hill (1994)

REFERENCE BOOKS:

1. Roy Billinton and Ronald N. Allan, Reliability Evaluation of Engineering Systems: Concepts and Techniques, Springer science-Business media, 1992.
2. Roy Billinton and Rajesh Karki, Reliability and Risk Evaluation of Wind Integrated Power Systems (Reliable and Sustainable Electric Power and Energy Systems Management), Springer, 2013.
3. Seifi, Hossein, Sepasian, Mohammad Sadegh, Electric Power System Planning-Issues, Algorithms and Solutions, Springer, 2011.
4. Leon K. Kirchmeyer, Economic Operation of Power Systems, Wiley, 2009.

COURSE CODE: **1152EE143**	COURSE TITLE: **SOLAR PHOTOVOLTAIC SYSTEMS**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

COURSE CATEGORY: Program Elective

PREAMBLE: This course emphasizes the growing demand of renewable energy sources especially harnessing power from sun. Solar Photo Voltaic technology and systems comprise of the fundamentals, design, optimization and application of solar photovoltaic systems for power generation on small and large scale electrification.

PRE-REQUISITES: Basic Electrical Engineering

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Familiar with basics of solar PV
- Familiar with various PV performance measure terminologies.
- Understand about manufacturing of PV cells & sizing aspects of PV systems.
- Understand about PV system components and apply them in installation practices & associated trouble shootings.
- Understand about PV system applications and associated safety measures.

COURSE OUTCOMES:

Upon the completion of the course students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the principle of direct solar energy conversion to power using PV	K2
CO2	Contrast the performance measures of PV	K2
CO3	Infer on solar cells & design aspects of solar PV	K2
CO4	Identify PV components and installation practices	K2
CO5	Develop ideas for working on solar PV systems and associated safety practices	K2

CORRELATION OF Cos WITH Pos AND PSOs

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L					H							L
CO2	H	M					L					H		
CO3	H	M			H		L					H		H
CO4	H	H					L							H
CO5	H	H	H		H	H	H		H		H		M	H

COURSE CONTENTS		
UNIT I	**SOLAR CELL FUNDAMENTALS**	**6**
Principle of solar energy conversion, Photovoltaic effect, Semiconductor properties, energy levels, basic equations. Solar cell structure, parameters of solar cell.		
UNIT II	**PV MODULE PERFORMANCE**	**6**
Solar PV modules & arrays, I-V &P-V characteristics, maximum power point ,series parallel combination, cell efficiency, fill factor, role of bypass & blocking diode, factors affecting output of a solar cell.		
UNIT III	**MANUFACTURING OF PV CELLS & DESIGN OF PV SYSTEMS**	**6**
Commercial solar cells – Production process of single crystalline silicon cells, multi crystalline silicon cells, amorphous silicon, cadmium telluride, copper indium gallium diselenide cells. Design of solar PV systems, cost estimation, various aspects, system simulation tools.		
UNIT IV	**SOLAR PV SYSTEMS INSTALLATIONS & TROUBLE SHOOTING**	**6**
Classification – Central Power Station System, Distributed PV System, Stand alone PV system, grid Interactive PV System, small system for consumer applications, hybrid solar PV system, concentrator solar photovoltaic. System components – PV arrays, inverters, batteries, charge controllers , net metering. PV array installation, operation, costs, reliability. Troubleshooting of PV system components.		
UNIT V	**PV SYSTEM APPLICATIONS & SAFETY**	**6**
Building-integrated photovoltaic units, grid connected central power stations, stand-alone devices for distributed power supply in remote and rural areas, Outlook for the Indian PV industry& challenges, Applications: solar home system, solar cars, Solar Charger, aircraft, space solar power satellites. Socio-economic and environmental merits of photovoltaic systems safety in Installation of solar PV systems		
		TOTAL: 45 PERIODS
TEXTBOOKS:		
1. Chetan Singh Solanki., *Solar Photovoltaic: "Fundamentals, Technologies and Application",* PHI Learning Pvt., Ltd., 2009. 2. Jha A.R., "*Solar Cell Technology and Applications"*, CRC Press,2010. 3. John R. Balfour, Michael L. Shaw, Sharlave Jarosek*., "Introduction to Photovoltaics",* Jones & Bartlett Publishers, Burlington, 2011.		
REFERENCE BOOKS:		
1. Chetan Singh Solanki "*Solar PV technology and system",* PHI learning private limited, 2015. 2. Luque A. L. and Andreev V.M., "*Concentrator Photovoltaic"*,Springer, 2007. 3. Partain L.D., Fraas L.M., "*Solar Cells and Their Applications"*, 2nd ed., Wiley, 2010. 4. S.P. Sukhatme, J.K.Nayak., "*Solar Energy",* Tata McGraw Hill Education Private Limited, New Delhi, 2010. 5. R.K Pachauri "*From Sun light to Electricity" TERI, 15th Reprint , 2013*		

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/113104084

LABORATOTY PRACTICES

1) To perform experiment to study I-V characteristics of SPV module.
2) To perform experiment to study series combination of SPV modules.
3) To perform experiment to study parallel combination of SPV modules.
4) To perform experiment to study effect of tilt angle on SPV module output.
5) To perform experiment to demonstrate the effect of shading on SPV module output.
6) To study the effect of shading on the output of solar panel.
8) To understand how to use various electrical measuring equipments.

WEB REFERENCES:

https://www.nrel.gov The **National Renewable Energy Laboratory** (**NREL**), located in Golden, Colorado, specializes in renewable energy and energy efficiency research and development. **NREL** is a government-owned, contractor-operated facility, and is funded through the United States Department of Energy.

https://nise.res.in/ National Institute of Solar Energy, an autonomous institution of Ministry of New and Renewable (MNRE), is the apex National R&D institution in the field Solar Energy. The Government of India

http://www.seriius.org/ (SERIIUS—the Solar Energy Research Institute for India and the United States—is co-led by the Indian Institute of Science (IISc)—Bangalore, India, and the National Renewable Energy Laboratory (NREL), Golden, Colorado, USA.)

COURSE CODE:	COURSE TITLE:	L	T	P	C
1152EE201	**APPLIED SOFT COMPUTING**	**2**	**0**	**2**	**3**

COURSE CATEGORY: Program Elective

PREAMBLE :

This course will cover fundamental concepts of Artificial Neural Networks (ANNs), Fuzzy logic (FL) and optimization techniques using Genetic Algorithm (GA), PSO, DE etc.

PREREQUISITE COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to,

- Understand the fuzzy logic operations, relations and inference systems
- Understand the architecture, learning methodologies of perceptron and back propagation algorithm
- Know basics of genetic and differential evolution algorithm
- Study different optimization techniques –PSO, Firefly, Artificial BEE algorithm etc
- Study soft computing techniques applications related to electrical engineering

COURSE OUTCOMES : Upon the successful completion of the course, students will be able to*:*

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Describe about fuzzification and defuzzification in a fuzzy logic controller	K2
CO2	Elaborate the architecture of an artificial neural network considering supervised and unsupervised learning	K2
CO3	Explain the concept and steps involved in genetic algorithm and differential evolution algorithm	K2
CO4	Discuss the steps of different optimization algorithms and how to apply for a given optimization problem	K2
CO5	Develop MATLAB based simulation models for solving basic electrical engineering problems using soft computing techniques	K3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	M		L							L	M	M
CO2	H	M	M		L							L	M	M
CO3	H	M	M		L							L	M	M
CO4	H	M	M		L							L	M	M
CO5	H	M	M	M	H				M			L	M	M

COURSE CONTENT :		
UNITI	**FUZZY LOGIC**	**7**
Fuzzy sets- logic operations and relation, fuzzy decisions making, fuzzy inference systems, design of fuzzy logic controller.		
UNITII	**ARTIFICIAL NEURAL NETWORKS**	**7**
Artificial neuron-Supervised and unsupervised learning-single layer perceptron, and multi-layer perceptron, back propagation neural network.		
UNITIII	**EVOLUTIONARY ALGORITHM**	**7**
Genetic algorithms: Introduction-genetic algorithm steps-selection, crossover, and mutation-Deferential Evolution Algorithm		
UNITIV	**SWARM INTELLIGENCE**	**9**
Particle swarm optimization(PSO)-Firefly algorithm(FA), Artificial BEE optimization(ABC) -Cat swarm optimization(CSO)-Bacterial foraging optimization(BFO)		
UNITV	**LIST OF EXPERIMENTS**	**15**
Case studies of soft computing applications to electrical engineering problems using MATLAB/SCI LAB a) Application of fuzzy logic for temperature control in refrigerator b) Fuzzy logic controller for speed control of stepper motor c) Emulating logic gates with a neural network d) Applications of genetic algorithm for speed control of induction motor e) Swarm intelligence for optimization problem in electrical engineering		
TOTAL: 45 PERIODS		

TEXT BOOKS:

1. S.N.Sivanandam and S.N.Deepa, “Principles of Soft Computing”, Wiley India Pvt Ltd, 2011.
2. Timothy Ross, “ Fuzzy Logic with Engineering Applications” ,(McGrawHill)
3. Jang, J.S.R., Sun, C.T. and Mizutani, E., ‘Neuro-fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence’, Prentice Hall, 2009.
4. K.A.D. Jo ng, ‘Evolutionary Computation – A Unified Approach’, PHI Learning, 2009.

REFERENCE BOOKS:

1. S. Haykin, ‘Neural Networks and Learning Machines’, Prentice Hall, 2009.
2. S.Rajasekaran, G.A. VijayalakshmiPai,"Neural Networks, Fuzzy logic & Genetic Algorithms", PHI, New Delhi
3. Deb, K., ‘Optimization for Engineering Design Algorithms and Examples’, Prentice Hall of India. 2009.
4. George J. Klir, Ute St. Clair, Bo Yuan, “Fuzzy Set Theory: Foundations and Applications” Prentice Hall, 1997.

COURSE CODE: **1152EE202**	COURSE TITLE: **SWITCH MODE POWER SUPPLY DESIGN AND DEVELOPMENT**	L	T	P	C
		4	**0**	**4**	**6**

COURSE CATEGORY: Program Elective

PREAMBLE :

The course is designed as lab dominated theory course to make the student acquire thorough knowledge in the field of power supply design for the given devices or equipments. Since power supply system is absolutely necessary for all equipments which produce constant voltage at the output irrespective of changes in supply voltage. This course is designed from understanding the fundamental of SMPS in designing an SMPS for the given equipments.

PREREQUISITE COURSES:

- Basic Electrical Engineering, Basic Electronics Engineering, Electronic Devices and Circuits, Power Electronics

COURSE EDUCATIONAL OBJECTIVES:

The objectives of this course are to,

- Analyse insight of SMPS and its various topologies
- Design concepts and fabrication of a modern power supply system for the given equipment.

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's taxonomy)
CO1	Explain the fundamental concept of SMPS	K2
CO2	Outline the working of rectifier, chopper, amplifier circuit, voltage and current sensors	K2
CO3	Explain the SMPS topologies	K2
CO4	Design SMPS for specific application	K4
CO5	Identify the power quality issues using power quality analyzer	K3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	L						L				M	
CO2	H	H	M						L		M	L	M	L
CO3	H	H	M						L		M	L	M	H
CO4	H	H	H	M	M				M		M	L	M	H
CO5	H	H	M	L	M				L		M	L	M	H

COURSE CONTENT:

UNIT I	**INTRODUCTION**	**12**

Introduction to SMPS-types-evolution- need of SMPS- Linear Regulator vs SMPS – Block

diagram-advantages-Applications		
UNIT II	**COMPONENTS**	**12**
Rectifier types and its operations-purpose of amplifier in SMPS-amplifier circuit used in SMPS-voltage regulator and its types-comparator and its types- importance of comparator-Chopper-definition-types-role of chopper in SMPS		
UNIT III	**SMPS CONVERTER TOPOLOGIES**	**12**
Buck, Boost, Buck-Boost, Push-Pull, Fly back, Resonant, forward Converter- Operation.		
UNIT IV	**DESIGN OF SMPS**	**12**
Selection of switching devices for SMPS-switching frequency-PWM techniques-switching losses-duty cycles- comparator design- need of voltage and current sensors and types		
UNIT V	**POWER QUALITY ASSESSMENT**	**12**
Power quality analyzer-block diagram and its working-applications-measurement of current and voltage harmonics at source side of SMPS -UPS output side-measurement of input power factor, analysis of power quality issues in load side for single phase and three phase loads		
		TOTAL: 60+60 PERIODS

TEXT BOOKS:

1. Maniktala, Sanjaya (2006), Switching Power Supplies A to Z, Newnes /Elsevier, ISBN 0-7506-7970-0

REFERENCE BOOKS:

1. Keith Billings, Taylor Morey, **Switch mode Power Supply Handbook,** Third Edition, McGraw-Hill Education, New York, 2012.
2. Abraham I. Pressman, Keith Billingss, Taylor Morey-Switching Power Supply Design, third edition, New York: McGraw-Hill, 1999
3. ON Semiconductor (July 11, 2002). "SWITCHMODE Power Supplies—Reference Manual and Design Guide" (PDF). Retrieved 2011-11-17.

LIST OF EXPERIMENTS

1. Identification, testing of components and its terminals used in SMPS
2. a. Selection of energy storage inductor, output filter capacitor.
   b. Study the working of various high frequency switching devices
3. a. Selection of switches, snubber circuit design
   b. Study of Magnetic circuits and Transformer
4. To Generate Pulse width modulation signal using different circuits
5. a. Design of feedback controller and amplifier circuit
   b. Op-amp circuits for current and voltage sensing in converters.
6. a. Measurement of output voltage using voltage sensor
   b. Study the working of tiny fly back step down transformer

7. Design and testing of a voltage regulator circuit
8. Design and testing of simple DC chopper
9. Design of non-isolated DC-DC converters in different operating modes
10. Microcontrollers selection to use in SMPS circuits
11. Study of popular PWM Control IC's (SG 3525,TL 494,MC34060 etc.)
12. Study of popular PFC Control ICs MC34062 and UC 3854
13. Design of driver circuits
14. Design and development of SMPS and measure the input power factor and THD of input voltage and current using a power quality analyzer.
15. Troubleshooting of SMPS.

COURSE CODE: **1152EE301**	COURSE TITLE: **VOLTAGE STABILIZER FABRICATION**	L	T	P	C
		0	**0**	**2**	**1**

COURSE CATEGORY:

Program Elective / University Elective

PREAMBLE :

This course includes the development of skills in power supply unit which is essential for all house hold appliances. This course is designed from understanding the fundamental of voltage stabilizer to designing a voltage stabilizer for the given power rating.

PREREQUISITE COURSES:

- Basic Electrical Engineering, Basic Electronics Engineering

RELATED COURSES:

- Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of this course are to,

- Identify the requirement of voltage stabilizer for domestic equipments.
- Procedure to design of transformer for a given power rating of voltage stabilizer
- Procedure for the design of relay driver circuit for voltage stabilizer
- Techniques for trouble shooting the voltage stabilizer for any problem

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's taxonomy)
CO1	Explain the basic concepts of voltage stabilizer	K2, S1
CO2	Build a transformer for voltage stabilizer	K3, S2
CO3	Build of relay driver circuit	K3, S2
CO4	Demonstrate voltage stabilizer for specific application	K3, S3
CO5	Demonstrate troubleshooting of voltage stabilizer	K3, S3

CORRELATION OF COs WITH POs AND PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L										L	H	L
CO2	H	L	L						M	L			L	H
CO3	H	L	L						M	L			L	H
CO4	H	L	M						M	M	M	L	M	H
CO5	H	L	M	H					M				H	H

COURSE CONTENT:

Design of voltage stabilizer

Introduction-Need of voltage stabilizer-Power rating calculation-Block diagram- complete circuit and its operation -Relay driver circuit design-Comparator design-Transformer design

LIST OF EXPERIMENTS

1. Identification of components and its terminals used in voltage stabilizer
2. Design and development of transformer for given power rating
3. Design and development of comparator circuit for voltage stabilizer
4. Design and development of relay driver circuit used in voltage stabilizer
5. Voltage measurement using voltage sensor
6. Design of amplifier circuit for voltage stabilizer
7. Demonstration and testing of voltage stabilizer for various input voltage.
8. Trouble shooting of voltage stabilizer

Total: 30 hrs

TEXT BOOK:

1. M. Lotia “Modern Voltage Stabilizer Servicing: Introduction, Basic Principle and Repairing”, ISBN 10: 8176562831 / ISBN 13: 9788176562836, BPB Publications, 2006.

REFERENCE BOOK:

1. Osama Butt “Automatic Voltage Stabilizer by Using Pulse Width Modulation”, ISBN 10: 365989317X / ISBN 13: 9783659893179, Published by LAP Lambert Academic Publishing Jun 2016, 2016.