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 AND COMMUNICATION

B.TECH. DEGREE PROGRAMME

ELECTRICAL AND ELECTRONICS ENGINEERING

VTR-UGE-2021 REGULATIONS

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

B.TECH - ELECTRICAL AND ELECTRONICS ENGINEERING

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 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**.**

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.

Minimum credits required for regular students in various course categories

Section Number	Course Category	Minimum Credits Required
7.2.1	Foundation Courses (FC)	56
7.2.2	Programme Core (PC)	58
7.2.3	Programme Elective (PE)	18
7.2.4	Open Elective (OE)	12
7.2.5	Independent Learning (IL)	14
7.2.6	Industry/Higher Institute Learning Interaction (IHL)	2
7.2.7	Professional Proficiency Courses (PPC)	4
	Total	**164**

Minimum credits required for Lateral Entry students in various course categories

Section Number	Course Category	Minimum Credits Required
7.2.1	Foundation Courses (FC)	22
7.2.2	Programme Core (PC)	48
7.2.3	Programme Elective (PE)	18
7.2.4	Open Elective (OE)	12
7.2.5	Independent Learning (IL)	14
7.2.6	Industry/Higher Institute Learning Interaction (IHL)	2
7.2.7	Professional Proficiency Courses (PPC)	4
	Total	**120**

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VTR UGE 2021 - EEE Curriculum

Programme Core (PC) Courses – Regular Students

List of Courses for 58 Credits

Sl.No	Course Code	Course Name	Page No.
1	10211EE101	Circuits Analysis	19
2	10211EE102	DC Machines & Transformers	21
3	10211EE103	AC Machines	23
4	10211EE104	Digital Electronics	25
5	10211EE105	Linear Control Systems	27
6	10211EE106	Measurements and Instrumentation	29
7	10211EE107	Transmission & Distribution	31
8	10211EE108	Power Electronics	33
9	10211EE109	Power System Analysis	35
10	10211EE110	Power System Operation & Control	37
11	10211EE111	Electrical Machine Design	39
12	10211EE112	Microprocessor & Microcontroller	41
13	10211EE113	Electronic Circuits	43
14	10211EE114	Linear Integrated Circuits	45
15	10211EE115	Protection and Switch Gear	47
16	10211EE201	Electromagnetic Fields	50
17	10211EE301	Circuits and Devices Lab	53
18	10211EE302	DC Machines & Transformers Lab	54
19	10211EE303	AC Machines Lab	56
20	10211EE304	Control & Instrumentation Lab	58
21	10211EE305	Microprocessor & Microcontrollers Lab	60
22	10211EE306	Analog and Digital Electronics Lab	62
23	10211EE307	Power Electronics Lab	63
24	10211EE308	Power System Simulation Lab	65

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VTR UGE 2021 - EEE Curriculum

Programme Core (PC) Courses – Lateral Students

List of Courses for 48 Credits

Sl.No	Course Code	Course Name	Page No.
1.	10211EE101	Circuits Analysis	19
2.	10211EE104	Digital Electronics	25
3.	10211EE105	Linear Control Systems	27
4.	10211EE107	Transmission and Distribution	31
5.	10211EE108	Power Electronics	33
6.	10211EE109	Power System Analysis	35
7.	10211EE110	Power System Operation and Control	37
8.	10211EE111	Electrical Machine Design	39
9.	10211EE112	Microprocessor and Microcontrollers	41
10.	10211EE113	Electronic Circuits	43
11.	10211EE114	Linear Integrated Circuits	45
12.	10211EE115	Protection and Switch Gear	47
13.	10211EE201	Electromagnetic Fields	50
14.	10211EE301	Circuits and Devices Lab	53
15.	10211EE304	Control and Instrumentation Lab	58
16.	10211EE305	Microprocessor and Microcontrollers Lab	60
17.	10211EE306	Analog and Digital Electronics Lab	62
18.	10211EE307	Power Electronics Lab	63
19.	10211EE308	Power System Simulation Lab	65

Programme Elective (PE) Courses

List of Courses for 18 Credits

Sl No.	Course Code	Lecture Courses	Page No.
Power Systems Domain			
1.	10212EE121	Power Quality Engineering	70
2.	10212EE122	High Voltage Engineering	72
3.	10212EE123	Advances in Power System	74
4.	10212EE124	Power Plant Engineering	76
5.	10212EE125	High Voltage Direct Current Transmission	78
6.	10212EE126	Load Forecasting and Generation Forecasting	80
7.	10212EE127	Load Dispatching	82
8.	10212EE128	Reactive Power Management	84
9.	10212EE129	Smart Grid	86
Power Electronics & Drives Domain			
1.	10212EE130	LED Lighting Technology	88
2.	10212EE131	Flexible AC Transmission Systems	90
3.	10212EE132	Modern Power Converters	92
4.	10212EE133	Automotive Electrical & Electronics Systems	94
5.	10212EE134	Fundamentals of Electric and Hybrid Vehicles	96
6.	10212EE135	Special Electrical Machines	98
7.	10212EE136	Electromagnetic Interference & Compatibility	100
8.	10212EE137	Solid State Drives	102
Embedded Systems Domain			
1.	10212EE138	Principles of Robotics	104
2.	10212EE139	Embedded Systems	106
3.	10212EE140	Embedded Control of Electric Drives	108
4.	10212EE141	VLSI System & Design	110
5.	10212EE142	Wearable Electronics	112

Instrumentation & Control Domain			
1.	10212EE143	Virtual Instrumentation	114
2.	10212EE144	Digital Control Systems	116
3.	10212EE145	Introduction to Nonlinear Dynamical Systems	118
4.	10212EE146	Discrete Time Signal Processing	120
5.	10212EE147	Signals and Systems	122
6.	10212EE148	Soft Computing	124
7.	10212EE149	Bio Medical Instrumentation	126
8.	10212EE150	Process Automation	128
Energy Domain			
1.	10212EE151	Utilization of Electrical Energy	130
2.	10212EE152	Energy Auditing and Management	132
3.	10212EE153	Electrical Safety & Safety Management	134
4.	10212EE154	Renewable Energy Sources	136
5.	10212EE155	Solar Electric Systems	138
6.	10212EE156	Wind Energy Conversion Systems	140
7.	10212EE157	Generation Planning	142
8.	10212EE158	Solar Photovoltaic Systems	144
Electronics Domain			
1.	10212EE159	Nano Electronics	146
2.	10212EE160	Green Electronics	148
3.	10212EE161	Automotive Electronics	150
4.	10212EE162	Vehicle Electronics	152
5.	10212EE163	Optoelectronic Devices	154
6.	10212EE164	Electronic Circuit Simulation and PCB Design	156
7.	10212EE165	Medical Electronics	158
Integrated Courses			
1.	10212EE201	Applied Soft Computing	160
2.	10212EE202	Switch Mode Power Supply Design and Development	162
3.	10212EE203	Electrical Machines (only for lateral entry students)	165
Laboratory Course			
1.	10212EE301	Voltage Stabilizer Fabrication	168

Open Elective Courses

List of Courses for 12 Credits

Sl.No	Course Code	Lecture Courses	Page No.
1.	10213EE101	Neural Network and Fuzzy Logic Control	172
2.	10213EE102	Bio Medical Instrumentation	174
3.	10213EE103	Introduction to Automation	176
4.	10213EE104	Virtual Instrumentation	178
5.	10213EE105	Finite Element Analysis	180
6.	10213EE106	EMI & EMC Techniques	182
7.	10213EE107	Power Supply Quality	184
8.	10213EE108	LED Lighting	186
9.	10213EE109	Transducers And Sensors	188
10.	10213EE110	Signals and Systems	190
11.	10213EE111	Wearable Electronics	192
12.	10213EE112	Embedded System	194
13.	10213EE113	Estimation For Electrical Wiring	196
14.	10213EE114	Renewable Energy Systems	198
15.	10213EE115	Automotive Electrical & Electronics Systems	200
16.	10213EE116	Hybrid Electric Vehicles	202
17.	10213EE117	Introduction to Robotics	204
18.	10213EE118	Standards, Calibration, Testing & Maintenance of Electrical Equipments	206
19.	10213EE119	Electrical Safety, Operation & Regulations	208
20.	10213EE120	Energy Conservation and Management	210
21.	10213EE121	Electrical Machines	212
22.	10213EE122	Industrial Electrical Systems	214

Sl.No	Course Code	Lecture Courses	Page No.
23.	10213EE123	Computer Aided Analysis of Electrical Apparatus	216
24.	10213EE124	Green Energy Resources	218
25.	10213EE125	Robotics and Automation	220
26.	10213EE126	Wind Energy Technology	222
27.	10213EE127	Electrical Safety and Safety Management	224
Integrated Courses			
28.	10213EE201	Switch Mode Power Supply design and Development	226
Laboratory Courses			
29.	10213EE301	Voltage Stabilizer Fabrication	229

B.Tech EEE Specialization in Computer Systems

List of Courses for 18 Credits

Sl.No	Course Code	Lecture Courses	Page No
1.	10212EE101	Computer Architecture	233
2.	10212EE102	Operating Systems	235
3.	10212EE103	Object Oriented Programming	237
4.	10212EE104	Data Structures and Algorithms	239
5.	10212EE105	Computer Networks and Communication	241
6.	10212EE106	Artificial Intelligence	243

Minor Degree in Electric Vehicle Technology
List of Courses for 18 Credits

Sl.No	Course Code	Lecture Courses	Page No
1.	10213EE131	Charging Station	247
2.	10213EE132	Battery Management System	249
3.	10213EE133	Electric Propulsion System and Control	251
4.	10213EE134	Hybrid Electric Vehicle Technologies	253
5.	10213EE135	Energy Storage Systems and Control	255
6.	10213EE136	Modelling and Simulation of EV	257

Minor Degree in Renewable Energy Sources
List of Courses for 18 Credits

S.No.	Course Code	Lecture Courses	Page No.
1.	10213EE141	Renewable Energy	261
2.	10213EE142	Wind Energy Conversion Systems	263
3.	10213EE143	Solar Photovoltaics: Fundamentals, Technology and Applications	265
4.	10213EE144	Conversion of Energy in Buildings	268
5.	10213EE145	Solar Thermal Energy Systems	270
6.	10213EE146	Distributed Generation and Integration of Renewable Energy with Grid	272

B.Tech. EEE with Honours in Smart Grid Technologies
List of Courses for 18 Credits

Sl.No	Course Code	Lecture Courses	Page No.
1.	10212EE171	Smart Grid	276
2.	10212EE172	Energy Management and SCADA	278
3.	10212EE173	Power System Restructuring	280
4.	10212EE174	Distributed Generation and Micro Grid	282
5.	10212EE175	IoT Applications in Smart Grid	284
6.	10212EE176	AI for Smart Grid Systems	286

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Programme Core (PC) Courses – Regular Students

S.NO.	COURSE CODE	COURSE NAME	L	T	P	C
LECTURE COURSES						
1.	10211EE101	Circuits Analysis	3	1	0	4
2.	10211EE102	DC Machines and Transformers	3	0	0	3
3.	10211EE103	AC Machines	3	0	0	3
4.	10211EE104	Digital Electronics	3	0	0	3
5.	10211EE105	Linear Control Systems	2	1	0	3
6.	10211EE106	Measurements and Instrumentation	2	0	0	2
7.	10211EE107	Transmission and Distribution	3	0	0	3
8.	10211EE108	Power Electronics	3	0	0	3
9.	10211EE109	Power System Analysis	3	1	0	4
10.	10211EE110	Power System Operation and Control	3	0	0	3
11.	10211EE111	Electrical Machine Design	3	1	0	4
12.	10211EE112	Microprocessor and Microcontrollers	3	0	0	3
13.	10211EE113	Electronic Circuits	3	0	0	3
14.	10211EE114	Linear Integrated Circuits	3	0	0	3
15.	10211EE115	Protection and Switch Gear	3	0	0	3
INTEGRATED COURSES						
16.	10211EE201	Electromagnetic Fields	2	0	2	3
LABORATORY COURSES						
17.	10211EE301	Circuits and Devices Lab	0	0	2	1
18.	10211EE302	DC Machines and Transformers Lab	0	0	2	1
19.	10211EE303	AC Machines Lab	0	0	2	1
20.	10211EE304	Control and Instrumentation Lab	0	0	2	1
21.	10211EE305	Microprocessor and Microcontrollers Lab	0	0	2	1
22.	10211EE306	Analog and Digital Electronics Lab	0	0	2	1
23.	10211EE307	Power Electronics Lab	0	0	2	1
24.	10211EE308	Power System Simulation Lab	0	0	2	1
		TOTAL				**58**

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VTR UGE 2021 - EEE Curriculum

Programme Core (PC) Courses – Lateral Entry students

S.NO.	COURSE CODE	COURSE NAME	L	T	P	C
LECTURE COURSES						
1.	10211EE101	Circuits Analysis	3	1	0	4
2.	10211EE104	Digital Electronics	3	0	0	3
3.	10211EE105	Linear Control Systems	2	1	0	3
4.	10211EE107	Transmission and Distribution	3	0	0	3
5.	10211EE108	Power Electronics	3	0	0	3
6.	10211EE109	Power System Analysis	3	1	0	4
7.	10211EE110	Power System Operation and Control	3	0	0	3
8.	10211EE111	Electrical Machine Design	3	1	0	4
9.	10211EE112	Microprocessor and Microcontrollers	3	0	0	3
10.	10211EE113	Electronic Circuits	3	0	0	3
11.	10211EE114	Linear Integrated Circuits	3	0	0	3
12.	10211EE115	Protection and Switch Gear	3	0	0	3
INTEGRATED COURSES						
13.	10211EE201	Electromagnetic Fields	2	0	2	3
LABORATORY COURSES						
14.	10211EE301	Circuits and Devices Lab	0	0	2	1
15.	10211EE304	Control and Instrumentation Lab	0	0	2	1
16.	10211EE305	Microprocessor and Microcontrollers Lab	0	0	2	1
17.	10211EE306	Analog and Digital Electronics Lab	0	0	2	1
18.	10211EE307	Power Electronics Lab	0	0	2	1
19.	10211EE308	Power System Simulation Lab	0	0	2	1
		TOTAL				**48**

Programme Core

THEORY COURSES

COURSE CODE: **10211EE101**	COURSE TITLE: **CIRCUIT ANALYSIS**	L	T	P	C
		3	**1**	**0**	**4**

COURSE CATEGORY: Programme 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: Electronics and Measurement 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 mesh and nodal analysis of DC and AC circuits	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**	**12**
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**	**12**
Superposition theorem - Thevenin's theorem - Norton's theorem - Maximum power transfer theorem - Reciprocity theorem.		
UNIT III	**NETWORK TOPOLOGY AND TWO PORT NETWORKS**	**12**
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**	**12**
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**	**12**
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: 60 PERIODS

TEXTBOOKS:

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

COURSE CODE:	COURSE TITLE:	L	T	P	C
10211EE102	**DC MACHINES & TRANSFORMERS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme Core

PREAMBLE: This course provides an introduction to the basic concepts of 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: Nil

RELATED COURSES: AC Machines, Electrical Machine Design

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Understand the fundamentals of rotating electrical machines.
- Provide the basic concept of DC machines and Transformers.
- 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 Realize the testing methods to determine the performance characteristics of Transformers	K2
CO5	Understand three phase transformer connections and parallel operation.	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:		
UNIT I	**BASIC CONCEPTS OF ROTATING MACHINES**	**9**
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 –Torque in wound rotor machine.		
UNIT II	**DC GENERATORS**	**9**
Constructional details – Principle of operation – Armature windings – lap and wave windings – Simplex and Multiplex windings – emf equation – Methods of excitation – Types – Characteristics - Armature Reaction – Compensating winding – Commutation – methods of improving Commutation		
UNIT III	**DC MOTORS**	**9**
Principle of operation – Back emf and torque equation – Types - Characteristics and application – starting of dc motors – Types of starters – Speed control of dc shunt and series motors – Testing of motors (Swinburne's and Hopkinson's test).		
UNIT IV	**SINGLE PHASE TRANSFORMERS**	**9**
Construction- Principle of operation - emf equation- Transformation ratio - Transformer on no-load - Parameters referred to HV/LV windings - Equivalent circuit - Transformer on load- Regulation - Losses and efficiency of transformers - testing of transformers: open circuit and short circuit tests, Sumpner's test.		
UNIT V	**THREE PHASE TRANSFORMERS**	**9**
Construction, types of connection and their comparative features, Scott connection, open delta connection, tertiary winding, Parallel operation of three-phase transformers, Load Sharing of Transformer. Tap changing transformers – No load and on load tap changing of transformers, Cooling of transformers - All day efficiency. Autotransformers - Saving of copper, applications.		
TOTAL: 45 PERIODS		
TEXTBOOKS:		
1. A.E.Fitzgerald, Charles Kingsley, Stephen.D.Umans, "Electric Machinery" Tata McGraw Hill Publishing Company Ltd, 2003. 2. Dr.P.S.Bimbhra, "Electrical Machinery", Khanna Publishers, 7th Edison, 2013		
REFERENCE BOOKS:		
1. P. C. Sen, "Principles of Electric Machines and Power Electronics" John Wiley and Sons, 2nd Edison, 1996. 2. D.P.Kothari and I.J.Nagrath, "Electric Machines", Tata McGraw Hill Publishing Company Ltd, 2002. 3. https://onlinecourses.nptel.ac.in/noc22_ee111/preview		

COURSE CODE:	COURSE TITLE:	L	T	P	C
10211EE103	**AC MACHINES**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme Core

PREAMBLE: The 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: Electrical Machine Design, 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.	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 – EMF, MMF and ZPF 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 - Capability curves.		
UNIT II	**SYNCHRONOUS MOTOR**	**9**
Principle of operation – Torque equation – infinite bus – V and inverted 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 –DOL, star-delta, autotransformer and rotor resistance starters – Speed control – Change of voltage, frequency, 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 and AC series motor.		
TOTAL: 45 PERIODS		
TEXTBOOKS:		
1. Dr. P.S. Bhimbra, 'Electrical Machinery', Khanna Publications, 7th Edition, 2007 2. D.P. Kothari and I.J. Nagrath, 'Electric Machines', Tata McGraw Hill Publishing Company Ltd, 2010		
REFERENCE BOOKS:		
1. A.E. Fitzgerald, Charles Kingsley, Stephen.D.Umans, 'Electric Machinery', Tata McGraw Hill Publishing Company Ltd, 2002. 2. B. L. Theraja and A.K. Theraja, " A Text Book of Electrical Technology", S. Chand Publication, 2002. 3. K. Murugesh Kumar, "Electric Machines", Vikas Publishing House Pvt Ltd, 2004. 4. P.S. Bhimbhra, "Electrical Machinery", Khanna Publishers, 2003. 5. https://nptel.ac.in/courses/108105131		

COURSE CODE: **10211EE104**	COURSE TITLE: **DIGITAL ELECTRONICS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme Core

PREAMBLE: The primary aim of this course is to understand the fundamentals of digital logic circuit design and gain experience. This course includes fundamentals of Boolean algebra, combinational circuits, sequential circuits and applications of digital electronics.

PREREQUISITE COURSES: Basic Electronics and Measurement Engineering

RELATED COURSES: Microprocessor and Microcontroller

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Familiar with number systems and Boolean algebra.
- Understand and explain sequential digital logic circuits.
- Design and implement combination logic circuits.
- 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	Understand the fundamentals of digital electronics.	K2
CO2	Develop combinational logic circuits for the given logical expressions.	K4
CO3	Understand the basic concepts of Flip-flops, Registers and Counters.	K2
CO4	Develop synchronous and asynchronous sequential circuits.	K4
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	H	M
CO2	H	H	H	H								M	H	M
CO3	H	H	H	H								M	H	M
CO4	H	H	H	H								M	H	M
CO5	M	L				M						L	L	L

COURSE CONTENT:		
UNIT I	**DIGITAL FUNDAMENTALS**	**9**
Analog and Digital Signals, introduction to Digital electronics, Number Systems-Types, fundamental binary arithmetic and logic operation,1's complement and 2's complement, code conversion. Introduction to Boolean algebra-Boolean postulates and laws – De-Morgan's Theorem – Principle of Duality – Boolean expression – Minimization of Boolean expressions.		
UNIT II	**COMBINATIONAL CIRCUITS**	**9**
Combinational logic representation of logic functions – SOP and POS forms, K-map representations – minimization using K-maps- simplification and implementation of combinational logic – multiplexers and demultiplexers – code converters, adders, subtractors.		
UNIT III	**SEQUENTIAL LOGIC CIRCUITS**	**9**
SR, JK, D and T flip-flops – level triggering and edge triggering – counters – Pulse forming circuits - asynchronous and synchronous type – Modulo counters – Shift registers – Ring counters.		
UNIT IV	**SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS**	**9**
Synchronous sequential circuits: State table and excitation tables - state diagrams, sequential circuit design using Mealy and Moore model, state reduction and state assignment Asynchronous sequential circuits: Transition table, flow table – race around conditions, circuits with latches, analysis procedure.		
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, FPGA		
		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. 4. https://onlinecourses.nptel.ac.in/noc22_ee110/preview		

COURSE CODE:	COURSE TITLE:	L	T	P	C
10211EE105	**LINEAR CONTROL SYSTEMS**	**2**	**1**	**0**	**3**

COURSE CATEGORY: Programme 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	**TRANSFER FUNCTION MODEL OF SYSTEMS**	**9**
Introduction to control systems - open loop and closed loop systems - Mathematical model of systems - Transfer Function - Transfer function model of electrical, mechanical and electromechanical systems - Analogies between electrical and mechanical systems - Block diagram algebra - Transfer function using block diagram reduction and Signal flow graph		
UNIT II	**TIME RESPONSE ANALYSIS**	**9**
Poles, zeros, type and order of system - Standard test signals - Time response of first order and second order systems - Time response specifications - Static error coefficients and steady state error – Introduction to P, PI and PID Controllers.		
UNIT III	**FREQUENCY RESPONSE ANALYSIS**	**9**
Introduction to frequency response - Correlation between Time and frequency response - Polar plot - Bode plots - Frequency response specifications - Basics of lead, lag and lead-lag compensators - Design of lag and lead compensators using Bode plots.		
UNIT IV	**SYSTEM STABILITY ANALYSIS**	**9**
Effects of addition of poles and zeros -Stability concepts - Conditions for stability - Stability analysis in time domain: Routh-Hurwitz criterion - Root locus concept - rules for constructing root locus diagram - Stability analysis in frequency domain: Nyquist stability criterion - Relative stability analysis		
UNIT V	**STATE SPACE MODEL OF SYSTEMS**	**9**
Introduction to State space – State Equations – Conversion of State space to transfer function and vice versa - State transition matrix - Solution of state equation through Laplace transform method - Controllability and Observability - Gilbert's test - Kalman's test.		
		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 Systems', Pearson Education, 11th Edition 2011.

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

COURSE CODE: **10211EE106**	COURSE TITLE: **MEASUREMENTS AND INSTRUMENTATION**	L	T	P	C
		2	**0**	**0**	**2**

COURSE CATEGORY: Programme Core

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

PREREQUISITE COURSES: Basic Electronics and Measurement Engineering

RELEVANT COURSES: Linear Control Systems

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.
- 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	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	**DC AND AC BRIDGES**	**6**
DC bridges: Wheatstone bridge, Kelvin's Bridge. AC bridges: Maxwell's bridg, Schering bridge, Wein bridge and Anderson bridge.		
UNIT IV	**STORAGE AND DISPLAY DEVICES**	**6**
Magnetic disk and tape – recorders, CRT display, digital CRO, LED, LCD & dot matrix display.Study of modern printers and display devices.		
UNIT V	**TRANSDUCERS AND DATA ACQUISITION SYSTEMS**	**6**
Classification of transducers – selection of transducers – resistive, capacitive & inductive transducers – temperature transducers: thermistor, thermocouple - LVDT, pressure transducers– strain gauges – Piezo electric – elements of data acquisition system.		
		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', DhanpatRai 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.
6. https://onlinecourses.nptel.ac.in/noc22_ee112/preview

COURSE CODE: **10211EE107**	COURSE TITLE: **TRANSMISSION AND DISTRIBUTION**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme Core

PREAMBLE: To become 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		
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.
4. https://onlinecourses.nptel.ac.in/noc22_ee98/preview

COURSE CODE: **10211EE108**	COURSE TITLE: **POWER ELECTRONICS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme Core

PREAMBLE: This course is 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: Circuit Analysis, Electronic Circuits

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 & Cyclo converter 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.
4. Cyril W.Lander, “Power Electronics”, McGraw-Hill, International edition, New Delhi, 1993.
5. https://nptel.ac.in/courses/108101126

COURSE CODE: **10211EE109**	COURSE TITLE: **POWER SYSTEM ANALYSIS**	L	T	P	C
		3	**1**	**0**	**4**

COURSE CATEGORY: Programme 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

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	K4
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**	**12**
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**	**12**
Introduction - Bus Classification - Bus admittance matrix - Solution of non-linear Algebraic equations – Gauss-Seidel method - Newton Raphson method - Fast decoupled method - Flow charts and comparison of the three methods.		
UNIT III	**FAULT ANALYSIS-BALANCED FAULT**	**12**
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**	**12**
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**	**12**
Basic concepts and definitions of stability – Classification of stability –Swing equation–Transient stability – Equal area criterion – Reponses to a short circuit fault- Factors influencing Transient stability – Numerical integration methods –Modified Euler method – Runge – Kutta methods.		
TOTAL: 60 PERIODS		
TEXT BOOKS:		
1. Hadi Saadat “Power System Analysis”, Tata McGraw Hill Publishing Company, New Delhi, 2002 2. P.Kundur, “Power System Stability and Control”, Tata McGraw Hill Publishing Company, New Delhi, 1994		
REFERENCE BOOKS:		
1. I.J.Nagrath and D.P.Kothari, ‘Modern Power System Analysis’, Tata McGraw-Hill publishing company, New Delhi, 1990. 2. https://nptel.ac.in/courses/108105104		

COURSE CODE: **10211EE110**	COURSE TITLE: **POWER SYSTEM OPERATION AND CONTROL**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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.
4. https://nptel.ac.in/courses/108105104

COURSE CODE: **10211EE111**	COURSE TITLE: **ELECTRICAL MACHINE DESIGN**	L	T	P	C
		3	**1**	**0**	**4**

COURSE CATEGORY: Programme 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: DC Machines and Transformers, AC 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	**CALCULATIONS OF MMF FOR ROTATING ELECTRICAL MACHINES**	**12**
Major considerations in Electrical Machine Design – Materials for Electrical apparatus – Design of Magnetic circuits – Real and Apparent flux densities–Magnetizing current – Flux leakage –Armature Leakage fluxes		
UNIT II	**DESIGN OF D.C MACHINES**	**12**
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	**DESIGN OF TRANSFORMERS**	**12**
Constructional features - Output equation, output rating of single phase and three phase, optimum design - Design of core, design of winding - Design of tank and cooling tubes - Temperature rise.		
UNIT IV	**DESIGN OF INDUCTION MACHINES**	**12**
Constructional details - Output equation - Choice of specific loadings – Design of stator–Design of squirrel cage rotor - Design of slip ring rotor		
UNIT V	**DESIGN OF SYNCHRONOUS MACHINES**	**12**
Construction details - Runaway speed - Output equations - Choice of loading - Design of salient pole machine - Short Circuit Ratio - Armature design - 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: 60 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
4. https://nptel.ac.in/courses/108105131
5. https://onlinecourses.nptel.ac.in/noc22_ee111/preview

COURSE CODE:	COURSE TITLE:	L	T	P	C
10211EE112	**MICROPROCESSOR AND MICROCONTROLLERS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme Core

PREAMBLE: The Purpose of the course is to provide 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 and 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 8085 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	Explain the peripherals devices such as 8255, 8279, 8251, 8253, 8259 and 8237.	K2
CO3	Describe the architecture and functional block of 8051 microcontroller	K2
CO4	Develop an embedded C and ALP in 8051 microcontroller using the internal functional blocks for the given specification	K3
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									L	H	M
CO3	H	M	L										H	M
CO4	H	M	M	L	M						M	M	H	M
CO5	H	M	L	L								M	H	M

COURSE CONTENT:		
UNIT I	**8085 MICROPROCESSOR**	**9**
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	**8085 MICROPROCESSOR PERIPHERAL DEVICES**	**9**
Parallel peripheral Interface (8255) - Timer / Counter (8253) - Keyboard and Display Controller (8279) - USART (8251) - Interrupt Controller (8259) - DMA Controller (8237).		
UNIT III	**8051 MICROCONTROLLER**	**9**
Architecture – memory organization –I/O ports and circuits-Timers - Interrupts –serial communication - Interfacing of External Memory-Interfacing LCD & Keyboard-RTC.		
UNIT IV	**8051 MICROCONTROLLER PROGRAMMING**	**9**
Addressing modes -instruction set -Assembly language programming and C Programming–Timer Counter Programming – Serial Communication Programming- Interrupt Programming.		
UNIT V	**APPLICATIONS OF MICROCONTROLLERS**	**9**
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 PEROIDS

TEXT BOOKS:

1. Ramesh S Gaonkar, 'Microprocessor Architecture, Programming and Application with 8085', 6th Edition, Penram International Publishing.
2. Muhammad Ali Mazidi, Janice GillispieMazidi and Rolin D McKinlay, 'The 8051 Microcontroller and Embedded Systems using Assembly and C', 2nd Edition Pearson education Asia.

REFERENCE BOOKS:

1. Mohamed Rafiquzzaman, 'Microprocessor and Microcomputer Based System Design', 2nd Edition, CRC press
2. Kenneth J Ayala, 'The 8051 Microcontroller Architecture Programming and Application', 3rdEdition, Penram International Publishers.
3. A.K Ray & K.M. Burchandi, 'Advanced Microprocessor and Peripherals Architectures, Programming and interfacing ', 2nd Edition, Tata McGraw-Hill.
4. https://nptel.ac.in/courses/108105102

COURSE CODE:	COURSE TITLE:	L	T	P	C
10211EE113	**ELECTRONIC CIRCUITS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme Core

PREAMBLE: This course gives a comprehensive exposure to all types of amplifiers and oscillators constructed with discrete components such as BJTs and FETs. Also, helps to develop a strong basis for building linear and digital integrated circuits.

PREREQUISITE COURSES: Basic Electronics and Measurement Engineering

RELATED COURSES: Linear Integrated Circuits, Digital Electronics

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to:

- Design amplifier and oscillator circuits.
- Classify and analyze power amplifier circuits.
- Understand the concept of feedback amplifiers and its topologies
- Understand the operation of pulse 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	Design BJT and FET amplifier and oscillator circuits.	K2
CO2	Analyze transistorized amplifier and oscillator circuits.	K4
CO3	Understand the concept of feedback amplifiers and its topologies	K4
CO4	Understand the applications of different oscillator circuits	K2
CO5	Analyze the working of attenuator, oscillator and multivibrator circuits.	K4

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	M
CO2	H	M	M	M								L	H	M
CO3	H	M	M	M								L	H	M
CO4	H	M	M	M								L	H	M
CO5	H	M	M									L	H	M

COURSE CONTENT:		
UNIT I	**SMALL SIGNAL AMPLIFIERS**	**9**
Biasing circuits of BJT and FET transistors, analysis and design of BJT and FET amplifiers, chopper stabilized amplifiers, case studies – application of current amplifiers in SCR firing circuits and power supplies.		
UNIT II	**LARGE SIGNAL AMPLIFIERS**	**9**
Power amplifiers- classification, analysis and design of class A and class B power amplifiers, class C and class D amplifiers, thermal considerations, tuned amplifiers.		
UNIT III	**FEEDBACK AMPLIFIERS**	**9**
Basic concept of feedback amplifiers, effect of negative feedback on gain, gain stability, distortion, bandwidth, input and output impedances; topologies of feedback amplifiers, case studies – application of negative feedback in dc-dc converters.		
UNIT IV	**OSCILLATORS**	**9**
Barkhausen criterion for oscillation – Hartley & Colpitt's oscillators – RC phase shift, Wien bridge and crystal oscillators - Clapp oscillator – oscillator amplitude stabilization.		
UNIT V	**PULSE CIRCUITS**	**9**
Attenuators – RC integrator and differentiator circuits – diode clampers and clippers –multivibrators - Schmitt Trigger- UJT Oscillator, case studies – application of UJT oscillator in SCR firing circuits and opto-electronic control circuits.		
TOTAL: 45 PERIODS		

TEXT BOOKS:

1. Jacob Millman, 'Microelectronics', McGraw Hill, 2nd Edition, Reprinted, 2009.
2. David A Bell, 'Fundamentals of Electronic Devices and Circuits', Oxford University Press, Incorporated, 2009.

REFERENCE BOOKS:

1. Allen Mottershead, 'Electronic Devices and Circuits-An Introduction', PHI, 18th Reprint, 2006.
2. Thomas L. Floyd, David M. Buchla, 'Electronics Fundamentals', Pearson Prentice Hall, 7th Edition, 2010.
3. Robert.L.Boylestad, 'Electronic Devices and Circuit Theory', Pearson, 10th Edition, 2009.
4. Sedra Smith, 'Microelectronic Circuits', Oxford University Press, 6th Edition, 2010.
5. Jacob Millman and Christos C. Halkias, 'Integrated Electronics: Analog and Digital Circuits and Systems', 2nd Edition, Tata McGraw Hill Education, 2011.
6. https://nptel.ac.in/courses/108105158

COURSE CODE: **10211EE114**	COURSE TITLE: **LINEAR INTEGRATED CIRCUITS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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 and Measurement Engineering, Electronic Circuits

RELATED COURSES: Circuit Analysis

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

COURSE CODE: **10211EE115**	COURSE TITLE: **PROTECTION AND SWITCH GEAR**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme Core

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.

PREREQUISITE COURSES: DC Machines and Transformer, Transmission and Distribution

RELATED COURSES: Nil

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	Understand the operating principles of electromagnetic relays.	K2
CO3	Understand the concept of microprocessor based numerical protective relays	K2
CO4	Summarize protection schemes for generation, transmission and distribution system	K2
CO5	Explain the principle of different Circuit breakers and its operation	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	L		L	L	L					L	H	L
CO3	H	L	L		H	L	L					L	H	L
CO4	H	L	L		L	L	L					L	H	L
CO5	H	L	L			L	L					L	H	L

COURSE CONTENT:		
UNIT I	**INTRODUCTION**	**9**
Basic ideas of short circuit currents and relay protection - basic terminology - essential qualities of a protective relay - The universal relay - torque equation, RX diagram - CT, PT & applications		
UNIT II	**ELECTROMAGNETIC RELAYS**	**9**
Electromagnetic relays–operating principles of relays-Over current relays –directional over current relays - distance relays - differential relays - under frequency and negative sequence relays - mho relay		
UNIT III	**MICROPROCESSOR BASED NUMERICAL RELAYS**	**9**
Introduction- IC elements and circuits for interfaces – A/D converter, Analog multiplier, S/H circuit-Overcurrent relays-Impedance relay-Directional relay- Reactance relay- Mho relay.		
UNIT IV	**PROTECTION OF POWER APPARATUS**	**9**
Generator protection - Transformer protection – Bus bar protection - Feeder protection - A.C. Motor protection and protection of transmission lines - Relay coordination of a sample system		
UNIT V	**CIRCUIT BREAKERS**	**9**
Arcing phenomena and arc quenching - circuit breaker rating– RRRV - Current Chopping and Capacitive current breaking – Construction and operation: Oil minimum circuit breakers, Air blast circuit breakers, Vacuum and SF6 circuit breakers.		
		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.MadhavaRao, “Power System Protection Static Relays”, Second Edition, Tata McGraw Hill, 2004
6. https://nptel.ac.in/courses/117107148

INTEGRATED COURSE

COURSE CODE: **10211EE201**	COURSE TITLE: **ELECTROMAGNETIC FIELDS**	L	T	P	C
		2	**0**	**2**	**3**

COURSE CATEGORY: Programme 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**	**6**
Sources and effects of electromagnetic fields – Coordinate Systems – Vector fields –Gradient, Divergence, Curl – theorems and applications - Coulomb's Law – Electric field intensity – Gauss's law and applications.		
UNIT II	**ELECTROSTATICS-II**	**6**
Electric potential – Electric field and equipotential plots, Uniform and Non-Uniform field– Electric field in free space, conductors, dielectrics – Dielectric strength – Boundary conditions, Poisson's and Laplace's equations.		
UNIT III	**MAGNETOSTATICS**	**6**
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 - Boundary conditions.		
UNIT IV	**ELECTRODYNAMIC FIELDS AND SOLUTION OF FIELD EQUATIONS**	**6**
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**	**6**
Electromagnetic wave generation and equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossy and lossless dielectrics- skin depth - Poynting vector, Application		
		TOTAL: 30 PERIODS

LIST OF EXPERIMENTS (30 PERIODS)

1. Analyzing flux distribution in core type transformer
2. Analyzing flux distribution in Shell type transformer
3. Analyzing Flux density of stepper motor
4. Analyzing the current distribution in the generator
5. Coulombs law with two charged objects
6. Electromagnetic induction
7. Charged particle in magnetic field
8. Study of force acting on the conductor in DC motor
9. Equipotential and electric field of two charges
10. Charged particle in an electric field

TEXT BOOKS:

1. Mathew N. O. Sadiku, 'Principles of Electromagnetics', 4th 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.

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:	COURSE TITLE:	L	T	P	C
10211EE301	**CIRCUITS AND DEVICES LAB**	**0**	**0**	**2**	**1**

COURSE CATEGORY: Programme Core

PREAMBLE: This course aims to make the students verify network theorems practically and understand circuits with three phase, and transients. It is also aimed to gain knowledge on characteristics of electronic devices.

PREREQUISITE COURSES: Basic Electronics and Measurement Engineering

RELATED COURSES: Control and Instrumentation Lab, Power Electronics Lab

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Verify the network theorems
- Understand the importance of two port network parameters.
- Understand the characteristics of various electronic devices.

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 and verify network theorems	K3, S2
CO2	Build the two port networks	K3, S2
CO3	Perform power measurement in electrical system	K3, S2
CO4	Perform characteristics of PN junction diode and BJT	K3, S2
CO5	Demonstrate the V-I characteristics of UJT, JFET and MOSFET	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				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:

Circuits

1. Verification of Thevenin's theorem.
2. Verification of Superposition theorem.
3. Measurement of two port network parameters.
4. Transient response of series RL and RC circuits.
5. Power and power factor measurement by two wattmeter method.

Devices

6. V-I characteristics of PN junction diode.
7. Characteristics of Common Emitter Configuration of Transistor
8. Characteristics of MOSFET
9. Characteristics of UJT
10. Characteristics of JFET

COURSE CODE: **10211EE302**	COURSE TITLE: **DC MACHINES & TRANSFORMERS LAB**	L	T	P	C
		0	**0**	**2**	**1**

COURSE CATEGORY: Programme 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, Linear Control Systems, 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

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 phase transformer
10. Load test on three phase transformer
11. Study of DC motor starters

COURSE CODE: **10211EE303**	COURSE TITLE: **AC MACHINES LAB**	L	T	P	C
		0	**0**	**2**	**1**

COURSE CATEGORY: Programme 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

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.	V and Inverted V curves of three phase synchronous motor
4.	Load test on three-phase induction motor
5.	Determination of equivalent circuit parameters of three phase induction motor
6.	Predetermine the performance characteristics of three phase induction motor using circle diagram
7.	Speed control of three phase slip ring 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 induction motor starters.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10211EE304	**CONTROL & INSTRUMENTATION LAB**	**0**	**0**	**2**	**1**

COURSE CATEGORY: Programme 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

LIST OF EXPERIMENTS

1. Design of P, PI and PID controller
2. Synchro-transmitter- receiver and characteristics
3. Determination of transfer function of DC servo motor
4. Determination of transfer function of AC servo motor
5. Design of Lag, Lead and Lag-Lead Compensators
6. Bridge Networks –AC and DC Bridges
7. Dynamics of Sensors/Transducers
   a. Temperature
   b. Pressure
   c. Displacement
   d. Optical
   e. Strain
   f. Flow
8. Instrumentation amplifier
9. Analog to digital and Digital to analog converter
10. Inverting, Non-inverting and differential amplifiers using op-amp

COURSE CODE:	COURSE TITLE:	L	T	P	C
10211EE305	**MICROPROCESSOR & MICROCONTROLLERS LAB**	**0**	**0**	**2**	**1**

COURSE CATEGORY: Programme 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

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:	COURSE TITLE:	L	T	P	C
10211EE306	**ANALOG AND DIGITAL ELECTRONICS LAB**	**0**	**0**	**2**	**1**

COURSE CATEGORY: Programme Core

PREAMBLE: This lab helps the students to develop their knowledge on analog and digital electronic circuits. The skills gained through the experiments will help the students to do their projects.

PREREQUISITE COURSES: Basic Electronics and Measurement Engineering

RELATED COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Understand the operation of amplifier and oscillator circuits
- Understand the basic concepts of logic gates
- Design combinational 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	Design and analyze the performance of amplifier circuits	K4,S3
CO2	Design and realize the Oscillator circuits	K4,S3
CO3	Understand the concept of logic gates	K1,S1
CO4	Understand and realize the combinational circuits using logic gates	K1,S1
CO5	Design and implement counter circuits	K4,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	L					M	L			M	H
CO2	H	M	M	L					M	L			M	H
CO3	H	M	M	L					M	L		L	M	H
CO4	H	M	M	L					M	L		L	M	H
CO5	H	M	M	L					M	L		L	M	H

LIST OF EXPERIMENTS:

Analog Circuits:

1. Frequency analysis of common emitter amplifier
2. Design of Class B power amplifiers
3. Design and verification of RC phase shift oscillator
4. Design of UJT relaxation oscillator
5. Design and implementation of Astable Multivibrator using 555 timer IC

Digital Circuits:

6. Realization of digital logic gates
7. Implementation of adder and subtractor circuits
8. Design and implementation of code converters using logic gates
9. Design of combinational circuits using multiplexer
10. Design and implementation of counters

COURSE CODE: **10211EE307**	COURSE TITLE: **POWER ELECTRONICS LAB**	L	T	P	C
		0	**0**	**2**	**1**

COURSE CATEGORY: Programme 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 DC-DC converters with control.	K3, S3
CO5	Demonstrate the working of phase-controlled AC-AC converters.	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		

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
8. Single phase AC voltage controller
9. Single phase cycloconverter
10. Three phase full converter.
11. Series resonant converter.

COURSE CODE: **10211EE308**	COURSE TITLE: **POWER SYSTEM SIMULATION LAB**	L	T	P	C
		0	**0**	**2**	**1**

COURSE CATEGORY: Programme 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

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.
11. Study of Microgrid

PROGRAMME ELECTIVE COURSES

List of Courses

S.NO.	COURSE CODE	COURSE NAME	L	T	P	C
POWER SYSTEMS DOMAIN						
1.	10212EE121	Power Quality Engineering	3	0	0	3
2.	10212EE122	High Voltage Engineering	3	0	0	3
3.	10212EE123	Advances in Power System	3	0	0	3
4.	10212EE124	Power Plant Engineering	3	0	0	3
5.	10212EE125	High Voltage Direct Current Transmission	3	0	0	3
6.	10212EE126	Load Forecasting and Generation Forecasting	3	0	0	3
7.	10212EE127	Load Dispatching	3	0	0	3
8.	10212EE128	Reactive Power Management	3	0	0	3
9.	10212EE129	Smart Grid	3	0	0	3
POWER ELECTRONICS & DRIVES DOMAIN						
1.	10212EE130	Led Lighting Technology	3	0	0	3
2.	10212EE131	Flexible AC Transmission Systems	3	0	0	3
3.	10212EE132	Modern Power Converters	3	0	0	3
4.	10212EE133	Automotive Electrical and Electronics Systems	3	0	0	3
5.	10212EE134	Fundamentals of Electric and Hybrid Vehicles	3	0	0	3
6.	10212EE135	Special Electrical Machines	3	0	0	3
7.	10212EE136	Electromagnetic Interference and Compatibility	3	0	0	3
8.	10212EE137	Solid State Drives	3	0	0	3
EMBEDDED SYSTEMS DOMAIN						
1.	10212EE138	Principles of Robotics	3	0	0	3
2.	10212EE139	Embedded Systems	3	0	0	3
3.	10212EE140	Embedded Control of Electric Drives	3	0	0	3
4.	10212EE141	VLSI System and Design	3	0	0	3
5.	10212EE142	Wearable Electronics	3	0	0	3
INSTRUMENTATION & CONTROL DOMAIN						
1.	10212EE143	Virtual Instrumentation	3	0	0	3
2.	10212EE144	Digital Control Systems	3	0	0	3
3.	10212EE145	Introduction to Nonlinear Dynamical Systems	3	0	0	3
4.	10212EE146	Discrete Time Signal Processing	3	0	0	3
5.	10212EE147	Signals and Systems	3	0	0	3
6.	10212EE148	Soft Computing	3	0	0	3

S.NO.	COURSE CODE	COURSE NAME	L	T	P	C
7.	10212EE149	Bio Medical Instrumentation	3	0	0	3
8.	10212EE150	Process Automation	3	0	0	3
ENERGY DOMAIN						
1.	10212EE151	Utilization of Electrical Energy	3	0	0	3
2.	10212EE152	Energy Auditing and Management	3	0	0	3
3.	10212EE153	Electrical Safety and Safety Management	3	0	0	3
4.	10212EE154	Renewable Energy Sources	3	0	0	3
5.	10212EE155	Solar Electric Systems	3	0	0	3
6.	10212EE156	Wind Energy Conversion Systems	3	0	0	3
7.	10212EE157	Generation Planning	3	0	0	3
8.	10212EE158	Solar Photovoltaic Systems	3	0	0	3
ELECTRONICS DOMAIN						
1.	10212EE159	Nano Electronics	3	0	0	3
2.	10212EE160	Green Electronics	3	0	0	3
3.	10212EE161	Automotive Electronics	3	0	0	3
4.	10212EE162	Vehicle Electronics	3	0	0	3
5.	10212EE163	Optoelectronic devices	3	0	0	3
6.	10212EE164	Electronic Circuit Simulation and PCB Design	3	0	0	3
7.	10212EE165	Medical Electronics	3	0	0	3
INTEGRATED COURSES						
1.	10212EE201	Applied Soft Computing	2	0	2	3
2.	10212EE202	Switch Mode Power Supply Design and Development	2	0	2	3
3.	10212EE203	Electrical Machines (only for lateral entry students)	2	0	2	3
LABORATORY COURSE						
1.	10212EE301	Voltage Stabilizer Fabrication	0	0	2	1

COURSE CODE: **10212EE121**	COURSE TITLE: **POWER QUALITY ENGINEERING**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

PREAMBLE: This course covers an introduction to power quality, voltage sags, overvoltage, harmonics and power quality monitoring

PREREQUISITE COURSES: Power Electronics, Protection and Switchgear

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 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	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. Alexander Kusko, Power Quality in Electrical Systems, McGraw-Hill, 2007.

COURSE CODE: **10212EE122**	COURSE TITLE: **HIGH VOLTAGE ENGINEERING**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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, Power Electronics

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 Pvt. Ltd. Reprint 2001. 2. M.S.Naidu and N.Kamaraju, "High Voltage Engineering" Tata Mc Graw Hill Publishing Company, New Delhi, 1983		
REFERENCE BOOKS:		
1. Subir Ray, 'An Introduction to High Voltage Engineering', PHI Learning Private Ltd 2004. 2. John Kuffel and Peter Kuffel, 'High Voltage Engineering Fundamentals', Second Edition, Elsevier, 2010		

COURSE CODE: **10212EE123**	COURSE TITLE: **ADVANCES IN POWER SYSTEM**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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

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. P.Kundur, 'Power System Stability and Control', McGraw Hill Education, 2007.
2. C.Sankaran, 'Power Quality" CRC Press, 2002.

REFERENCE BOOKS:

1. R.K.Rajput, 'A Text Book of Power System Engineering', Laxmi Publication, 2011
2. Jos Arillaga, 'Power System Harmonics', 2nd Edition, Kindle Edition, Wiley, 2007

COURSE CODE: **10212EE124**	COURSE TITLE: **POWER PLANT ENGINEERING**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

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

PREREQUISITE COURSES: Basic Electronics and Measurement 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 - Fluidized bed combustion - Coal handling systems - Ash handling systems - Forced draft and induced draft fans – Boilers Feed pumps - Super heater - Turbines - Regenerator - Condenser - Deaerators – 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. Bernhardt G.A.Skrotzki and William A. Vopat, 'Power Station Engineering and Economy', Tata Mc Graw Hill Publishing Company Ltd., New Delhi, 20th reprint, 2002.
2. P.K Nag, 'Power Plant Engineering' Tata McGraw Hill Second Edition, 2001.

REFERENCE BOOKS:

1. G.D. Rai, 'An Introduction to Power Plant Technology', Khanna Publishers, 1987.
2. Arora and Domkundwar, 'A Course in Power Plant Engineering', Dhanpat Rai and Co. Pvt. Ltd., 2011.
3. M.M. EI-Wakil, 'Power Plant Engineering', McGraw Hill, 1985.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE125	**HIGH VOLTAGE DIRECT CURRENT TRANSMISSION**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme 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 Analysis and Power Electronics

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 Modelling 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 Modelling 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 International (P) Ltd., New Delhi, 1990.

COURSE CODE: **10212EE126**	COURSE TITLE: **LOAD FORECASTING AND GENERATION FORECASTING**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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. S.A. Soliman, Ahmad Mohammad Al-Kandari 'Electrical Load Forecasting: Modeling and Model Construction' 1st Edition, Springer, 2010.
2. Allen J.Wood, Bruce F. Wollenbarg, "Power Generation, Operation and Control", John Wiley and Sons, 1984.

REFERENCE BOOKS:

1. 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.

COURSE CODE: **10212EE127**	COURSE TITLE: **LOAD DISPATCHING**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

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

PREREQUISITE COURSES: Power System Operation and Control

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. P.Kundur, 'Power System Stability and Control' McGraw Hill Education, 2011		
REFERENCE BOOKS:		
1. R.K.Rajput, 'A Text Book of Power System Engineering', Laxmi Publication, 2011 2. Mariani.E, Murthy.S.S, 'Advanced Load Dispatch for Power Systems', Springer, 2012		

COURSE CODE: **10212EE128**	COURSE TITLE: **REACTIVE POWER MANAGEMENT**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

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

PREREQUISITE COURSES: Circuit Analysis and 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:	COURSE TITLE:	L	T	P	C
10212EE129	**SMART GRID**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme 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. 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. Yokoyama, 'Smart Grid: Technology and Applications', John Wiley & Sons Inc, 2012.
3. Clark W.Gellings, 'The Smart Grid: Enabling Energy Efficiency and Demand Response', Fairmont Press Inc,2009.
4. Qi Huang, Shi Jing 'Innovative Testing and Measurement Solutions for Smart Grid', John Wiley & Sons Inc, 2015.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE130	**LED LIGHTING TECHNOLOGY**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme 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

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- State the need for Illumination.
- Define good Illumination.
- List standard voltage levels.
- Application of power electronics on LED technology.
- Define the aspects of design of lighting systems.
- Maintain the lighting systems
- Rectify fault in 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; Centralized 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. Amar K.Ganguly, 'Optoelectronic Devices and Circuits-Theory and Applications', Narosa Publishing House, 2010. 2. P.S.Bimbhra, 'Power Electronics', Khanna Publishers, 2015.		
REFERENCE BOOKS:		
1. E. Fred Schubert, 'Light-Emitting Diodes' Cambridge University Press, 2014. 2. Anil Valia, 'Light Design', Mili Jain Publishers, 2012.		

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE131	**FLEXIBLE AC TRANSMISSION SYSTEMS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

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

PREREQUISITE COURSES: Power 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, modelling and applications of SVC.
- Familiar with the operation, modes, modelling and applications of TCSC.
- Study the principle, characteristics, modelling 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 Modelling, Operation and control strategies of Static series compensation-SVC	K2
CO4	Explain the voltage source-based FACTS controllers	K2
CO5	Explain the modelling 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, 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. Miller. T.J.E., 'Reactive Power Control in Electric System', John Wiley & Sons, 1997.
5. Dubey G.K., 'Thyristorized Power Controller', New Age international (P) Ltd. 2001.
6. Song, Y.H. and Allan T. Johns, 'Flexible ac transmission systems (FACTS)', Institution of Electrical Engineers Press, London, 1999.

COURSE CODE: **10212EE132**	COURSE TITLE: **MODERN POWER CONVERTERS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

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

PREREQUISITE COURSES: Power Electronics

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Explain about the Single-phase bridge rectifiers with RL, RLE loads & effect of source impedance
- Explain about the three phase bridge rectifiers with RL, RLE loads & effect of source impedance
- Teach about design and analysis of dc –dc converters
- Present 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.		

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE133	**AUTOMOTIVE ELECTRICAL & ELECTRONIC SYSTEMS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme 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: Electronic Circuits

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Explain the basic layout of an automotive electrical system
- Illustrate the Starting and Charging systems of a vehicle.
- Describe about the Sensors and Actuators used in an Automobile.
- Explain the control systems used within a vehicle.
- Illustrate 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. William B. Ribbens, Norman P. Mansour 'Understanding Automotive Electronics', Elsevier, 2012
2. P L Kohli 'Automotive Electrical Equipment' Tata McGraw-Hill Education, 2004.

REFERENCE BOOKS:

1. Tom Denton 'Automobile Electrical and Electronics Systems', Elsevier, 4th Edition, 2012.
2. Robert Bosch 'Automotive Handbook' SAE, 1st Edition, 2011.
3. Dr.Kirpal Singh, 'Automobile Engineering', Standard Publishers, Vol- 1 and Vol- 2, 2012.
4. R.K. Jurgen, 'Automotive Electronics Handbook', McGraw Hill, 2nd Edition 2010.

COURSE CODE: **10212EE134**	COURSE TITLE: **FUNDAMENTALS OF ELECTRIC & HYBRID VEHICLES**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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: Power Electronics, Basic Electronics and Measurement Engineering

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.
2. Larminie, James, and John Lowry 'Electric Vehicle Technology' John Wiley & Sons, Ltd. 2003

REFERENCE BOOKS:

1. Emadi, Ali, 'Handbook of Automotive Power Electronics and Motor Drives' CRC Press, 2005.
2. Ehsani, Mehrdad, Yimin Gao, and Ali Emadi 'Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design' CRC press, 2009.
3. Soylu, Seref, 'Electric Vehicles: The Benefits and Barriers' InTech, 2011.
4. Soylu, Seref. 'Electric Vehicles–Modelling and Simulations' InTech Europe, Rijeka, Croatia, 2011.

COURSE CODE: **10212EE135**	COURSE TITLE: **SPECIAL ELECTRICAL MACHINES**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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: DC Machines and Transformers, AC Machines

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, and 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 – Sensor less 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 – Modelling, Simulation, Analysis, Design and Applications" CRC Press, 2001		

COURSE CODE: 10212EE136	COURSE TITLE: ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	L	T	P	C
		3	0	0	3

COURSE CATEGORY: Programme 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.

REFERENCE BOOKS:

1. Bridges, J.E Milleta J. and Ricketts.L.W., 'EMP Radiation and Protective Techniques', John Wiley and Sons, USA 1976.

COURSE CODE: **10212EE137**	COURSE TITLE: **SOLID STATE DRIVES**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

PREAMBLE: This course provides an introduction to the operation of electric drives controlled from a power electronic converter and also provides the design concepts of controllers.

REREQUISITE COURSES: Electrical Machines, Power Electronics

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 DC 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

COURSE CODE: **10212EE138**	COURSE TITLE: **PRINCIPLES OF ROBOTICS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

PREAMBLE: This course will impart the basic concepts of robotics and their design manufacture, application, and structural disposition

PREREQUISITE COURSES: Microprocessor & Microcontrollers

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, 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 Introduction", Holt – Saunders International Edition, Japan, 1985.

COURSE CODE: **10212EE139**	COURSE TITLE: **EMBEDDED SYSTEMS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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 & Microcontrollers

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.

REFERENCE BOOKS:

1. R. Mall, 'Real Time Systems Theory and Practice', Pearson, 2008.
2. Jean J.Labrosse, 'Embedded System Building Blocks', CMP Books, 2nd Edition, 1999
3. T. Noergaard, 'Embedded Systems Architecture: A Comprehensive Guide for Engineers and Programmers', Newness 2005.
4. Dr. Prasad, 'Embedded Real Time System', Wiley Dreamtech, 2004.

COURSE CODE: **10212EE140**	COURSE TITLE: **EMBEDDED CONTROL OF ELECTRICAL DRIVES**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

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

PREREQUISITE COURSES: Microprocessor & Microcontrollers

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 basic's 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 – feedback 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, 2nd Edition.
3. Nagrath. I. J, Gopal. M, 'Control Systems Engineering', New Age International Publishers, 3rd Edition.

COURSE CODE: **10212EE141**	COURSE TITLE: **VLSI SYSTEM & DESIGN**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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: Electronic Circuits, Linear Integrated Circuits

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, and 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' Addison Wesley, 2nd Edition, 1993 2. Samir Palnitkar, 'Verilog HDL – Guide to Digital Design and Synthesis', 3rd Edition, Pearson Education, 2003		

COURSE CODE: **10212EE142**	COURSE TITLE: **WEARABLE ELECTRONICS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

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

PREREQUISITE COURSES: Basic Electronics and Measurement 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 nanofibers
- 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 nanofibers		
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: **10212EE143**	COURSE TITLE: **VIRTUAL INSTRUMENTATION**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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.

REFERENCE BOOKS:

1. Kevin James, 'PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control', Newnes, 2000.
2. Robert H. Bishop, 'Learning with Lab-view', Prentice Hall of India, 2003.
3. Gary W. Johnson, Richard Jennings, 'Lab-view Graphical Programming', McGraw-Hill Professional Publishing, 2001.
4. Jovitha Jerome, 'Virtual Instrumentation Using LabVIEW', PHI Learning, 2010

COURSE CODE: **10212EE144**	COURSE TITLE: **DIGITAL CONTROL SYSTEMS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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: Linear 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 / nonlinear 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. Kautshiko Ogata 'Discrete Time Control Systems', Pearson Education ,2nd Edition 2015
2. M.Gopal, 'Digital Control and State Variable Methods', TMH Publication, 2nd Edition, 2014

REFERENCE BOOKS:

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

COURSE CODE: **10212EE145**	COURSE TITLE: **INTRODUCTION TO NONLINEAR DYNAMICAL SYSTEMS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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: Linear 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. Stephen Wiggins, 'Introduction to Applied Nonlinear Dynamical Systems and Chaos', 2nd Edition, Springer 2010
2. Steven H Strogatz, 'Nonlinear Dynamics and Chaos with applications to Physics, Biology, Chemistry and Engineering', Indian Edition by Levant Books, 2007

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE146	**DISCRETE TIME SIGNAL PROCESSING**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

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 McGraw Hill, 2007.
4. A.V.Oppenheim, R.W. Schafer and J.R. Buck, 'Discrete-Time Signal Processing', 8th Indian Reprint, Pearson, 2004.
5. Andreas Antoniou, "Digital Signal Processing", Tata McGraw Hill, 2006.

COURSE CODE: **10212EE147**	COURSE TITLE: **SIGNALS AND SYSTEMS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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: Linear Control System, Engineering Mathematics

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', 2nd 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.

COURSE CODE: **10212EE148**	COURSE TITLE: **SOFT COMPUTING**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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 neurons, BPN, RBF, TDNN- associative memory network: auto-associative memory network, hetero-associative memory network, BAM, Hopfield networks, iterative auto associative 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.

COURSE CODE: **10212EE149**	COURSE TITLE: **BIO MEDICAL INSTRUMENTATION**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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 Electronics and Measurement 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.

REFERENCE BOOKS:

1. John G. Webster, 'Medical Instrumentation Application and Design', John Wiley and Sons, New York, 1998.
2. Khandpur R.S, 'Handbook of Biomedical Instrumentation', Tata McGraw-Hill, New Delhi, 2nd Edition, 2003.
3. Duane Knudson, 'Fundamentals of Biomechanics', Springer, 2nd Edition, 2007.
4. Ed. Joseph D. Bronzino, 'Biomedical Engineering Hand Book', Third Edition, Boca Raton, CRC Press LLC, 2006.
5. M. Arumugam, 'Bio-Medical Instrumentation', Anuradha Agencies, 2003.

COURSE CODE: **10212EE150**	COURSE TITLE: **PROCESS AUTOMATION**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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. Frank Petruzella, 'Programmable Logic Controllers', 3rd Edition, by, Tata McGraw Hill Publications, 2010
2. George Bolton, 'Programmable Logic Controllers', 5th Edition, Elsevier India Publications, 2008

REFERENCE BOOKS:

1. Webb John W, Reis Ronald A, 'Programmable Logic Controllers', PHI learning Pvt Ltd.,2007
2. Hackworth, 'Programmable Logic Controllers: Programming Methods and Applications', 1st Edition, Pearson India Publications.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE151	**UTILIZATION OF ELECTRICAL ENERGY**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

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

PREREQUISITE COURSES: Nil

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.		
REFERENCE BOOKS:		
1. Alexander Kusko 'Power Quality in Electrical Systems', McGraw-Hill Professional, 2007 2. Soni A. Chakrabarti, M.L.Soni, P.V.Gupta, U.S.Bhatnagar, 'A Text Book on Power System Enggineering', Khanna Publishers, 2000. 3. A.I.Starr, 'Generation, Transmission and Utilization of Electric Power', ELBS, 1978.		

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE152	**ENERGY AUDITING AND MANAGEMENT**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

PREAMBLE: This course will helps to understand the various terms and methodology associated with energy audit.

PREREQUISITE COURSES: Nil

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: **10212EE153**	COURSE TITLE: **ELECTRICAL SAFETY AND SAFETY MANAGEMENT**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

PREAMBLE: This course will helps to know the basic concepts of electrical safety and regulations

PREREQUISITE COURSES: Nil

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 firefighting 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

COURSE CODE: **10212EE154**	COURSE TITLE: **RENEWABLE ENERGY SOURCES**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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

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 environment 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.
2. othari P, K C Singal and Rakesh Ranjan, 'Renewable Energy Sources and Emerging Technologies', PHI Pvt. Ltd., New Delhi, 2008.

REFERENCE BOOKS:

1. KSukhatme S P and Nayak J K, 'Solar Energy - Principles of Thermal Collection and Storage', Tata McGraw Hill, 2008.
2. Frank Kreith and Yogi Goswami D, 'Handbook of Energy Efficiency and Renewable Energy', CRC Press, 2007.
3. Bent Sorensen, 'Renewable Energy', Academic Press, 2004.
4. Abbasi S A and Naseema Abbasi, 'Renewable Energy Sources and their Environmental Impact', PHI Private Limited, 2001.

COURSE CODE: **10212EE155**	COURSE TITLE: **SOLAR ELECTRIC SYSTEMS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

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

PREREQUISITE COURSES: Nil

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

REFERENCE BOOKS:

1. SM Sze, Kwok K '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. SJ Fonash, 'Solar Cell Device Physics', Academic Press, 1982.
4. Richard C Neville, RC Neville, Bas Van Der Hoek 'Solar Energy Conversion- The Solar Cell', Elsevier Science & Technology.

COURSE CODE: **10212EE156**	COURSE TITLE: **WIND ENERGY CONVERSION SYSTEMS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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 Electronics and Measurement Engineering

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. VVN Kishore, 'Renewable Energy Engineering and Technology – A Knowledge Compendium', TERI Press, 2008.
2. Martin OL Hansen 'Aerodynamics of Wind Turbines', 2nd Edition, Earthscan, London.

REFERENCE BOOKS:

1. Johnson, G.L., 'Wind Energy Systems', Prentice Hall, 1985.
2. B.H.Khan 'Non-Conventional Energy Sources', Tata McGraw-Hill Education, 2006.
3. Paul Gipe, 'Wind energy Basics: A Guide to Small and Micro Wind', Chelsea Green Publishing, 2008.
4. L. L. Freris, 'Wind Energy Conversion systems', Prentice Hall, UK, 1990.

COURSE CODE: **10212EE157**	COURSE TITLE: **GENERATION PLANNING**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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 Operation and Control

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 System', Wiley, 2009.

COURSE CODE: **10212EE158**	COURSE TITLE: **SOLAR PHOTOVOLTAIC SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme 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 Electronics and Measurement 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**	**9**
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**	**9**
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**	**9**
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**	**9**
Classification - Central Power Station System, Distributed PV System, Standalone 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**	**9**
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.

REFERENCE BOOKS:

1. Chetan Singh Solanki 'Solar PV Technology and System', PHI Learning Private Limited, 2015.
2. Partain L.D., Fraas L.M., 'Solar Cells and Their Applications', 2nd Edition, Wiley, 2010.
3. S.P. Sukhatme, J.K.Nayak., 'Solar Energy', Tata McGraw Hill Education Private Limited, New Delhi, 2010.
4. R.K Pachauri 'From Sun light to Electricity' TERI, 15th Reprint, 2013

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE159	**NANO ELECTRONICS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

PREAMBLE: The purpose of the course is to provide students with the basic knowledge in nano electronics. This course emphasize on nano materials, types, synthesis, interconnects and fabrication.

PREREQUISITE COURSES: Engineering Physics

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Know the types of nanotechnology, atomic structure, molecular technology and preparation of nano materials.
- Understand the fundamentals of nano electronics and its properties.
- Know the Silicon MOSFET's, QTD and carbon nano tubes.
- Understand the fundamentals of molecular 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	Discuss the types of nanotechnology, molecular technology and the preparation of nano materials.	K2
CO2	Explains the fundamental of the devices such as logic devices, field effect devices, and spintronics.	K2
CO3	Describe the concepts of silicon MOSFET and Quantum Transport Devices.	K2
CO4	Summarize the types, synthesis, interconnects and applications of carbon nano tubes.	K2
CO5	Explain the concepts, functions, fabrications and applications of molecular 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	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	INTRODUCTION TO NANOTECHNOLOGY	9

Introduction: Discussion of International Technology Roadmap characteristics: Need for new concepts in electronics from microelectronics towards biomolecule electronics.

Background to nanotechnology: Types of nanotechnology and nanomachines – periodic table – atomic structure – molecules and phases – energy – molecular and atomic size – surface and dimensional space – top down and bottom up.

Molecular Nanotechnology: Electron Microscope – Scanning Electron Microscope – Atomic Force Microscope –Scanning Tunneling Microscope.

Nanomaterials: Preparation –Plasma Arcing – Chemical Vapor Deposition – Sol-Gels – Electrode Position – Ball Milling –Applications Of Nanomaterials.

UNIT II	FUNDAMENTALS OF NANO ELECTRONICS	9

Fundamentals of logic devices: requirements – dynamic properties – threshold gates; physical limits to computations; concepts of logic devices: classifications – two terminal devices – field effect devices – coulomb blockade devices – spintronics – quantum cellular automata – quantum computing – DNA computer; performance of information processing systems;- basic binary operations, measure of performance processing capability of biological neurons – performance estimation for the human brain. Ultimate computation: power dissipation limit – dissipation in reversible computation – the ultimate computer.

UNIT III	SILICON MOSFETs & QUANTUM TRANSPORT DEVICES	9

Silicon MOSFETS - Novel materials and alternate concepts: fundamentals of MOSFET Devices- scaling rules – silicon-dioxide based gate dielectrics – metal gates – junctions & contacts – advanced MOSFET concepts. Quantum transport devices based on resonant tunneling: Electron tunneling – resonant tunneling diodes – resonant tunneling devices; Single electron devices for logic applicationsSingle electron devices – applications of single electron devices to logic circuits.

UNIT IV	CARBON NANOTUBES	9

Carbon Nanotube: Fullerenes - types of nanotubes – formation of nanotubes – assemblies - purification of carbon nanotubes – electronic properties – synthesis of carbon nanotubes – carbon nanotube interconnects – carbon nanotube FETs – nanotube for memory applications – prospects of all carbon nanotube nanoelectronics.

UNIT V	MOLECULAR ELECTRONICS	9

Electrodes & contacts – functions – molecular electronic devices – first test systems – simulation and circuit design – fabrication; Future applications: MEMS – robots – random access memory – mass storage devices.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Michael Wilson, KamaliKannangara, Geoff Smith, Michelle Simmons and Burkhard
2. Raguse, Nanotechnology: Basic Science and Emerging Technologies, Chapman & Hall / CRC, 2002.

REFERENCE BOOKS:

1. Rainer Waser (Ed.), Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices, Wiley-VCH, 2003.
2. T. Pradeep, NANO: The Essentials – Understanding Nanoscience and Nanotechnology, TMH, 2007.M.Ziese and M.J Thornton (Eds.)"Spin Electronics ", Springer-verlag 2001.
3. M.Dutta and M.A Stroscio Edited by "Quantum Based Electronic Devices and systems", world Scientific, 2000.

ONLINE RESOURCES

1. https://www.edx.org/course/fundamentals-nanoelectronics-part-b-purduex-nano521x

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE160	**GREEN ELECTRONICS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

PREAMBLE: This course aims to provide students with knowledge on the theories, eco-design concepts, methods, and relevant hands-on experience for designing a range of sustainable green electronic products. It is expected that students will develop their ability to address relevant issues on environmental impact; product design, operating life, and the 3R concept (reduce, reuse, and recycle)

PREREQUISITE COURSES: Environment Engineering

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Study the introduction of green electronics
- Study the green electronics materials and products
- Study the green electronics assembly and recycling
- Study the flip-chip assembly and bonding for lead-free 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	Recognise and address the issues relating to the need for a greener world, and environmental electronic design and manufacturing in the local industry	K2
CO2	Recognise the importance of various environmental regulations in indifferent major countries around the world and the need for compliance with these regulations	K2
CO3	Apply the principles and practices of green electronics in selected consumer products	K2
CO4	Describe the process and techniques of assessment of the environmental hazards and suggest ways to reduce them.	K2
CO5	Realize the impact of the environmental regulations on the design, supply chain, manufacturing and recycling of the electronic products.	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	**INTRODUCTION OF GREEN ELECTRONICS**	**9**
Environmental concerns of the modern society – Overview of electronics industry and their relevant regulations in China, European Union and other key countries. Restriction of Hazardous substances (RoHs) – Waste Electrical and electronic equipment (WEEE) – Energy using Product (EUP) and Registration Evaluation, Authorization and Restriction of Chemical substances (REACH).		
UNIT II	**GREEN ELECTRONICS MATERIALS AND PRODUCTS**	**9**
Introduction to green electronic materials and products – Lead (Pb) – free solder pastes, conductive adhesives, halogen-free substrates and components. Substitution of non-recyclable thermosetting polymer based composites with recyclable materials X-Ray Fluorescence (XRF) for identifying hazardous substances in electronic products. Tin Whiskers Growth in Lead-Free Electronic Assemblies – Factors Influence Whisker Growth – Ways to Mitigate Tin Whisker Risk – Use Finite Element Modeling to Assess Tin Whisker Risk – Evaluation of Tin Whisker Impact on High-Reliability Applications.		
UNIT III	**GREEN ELECTRONICS ASSEMBLY AND RECYCLING**	**9**
Green electronic Assembly – Soldering Process – Lead-Free Solder Tip and Bumps – Mitigate Deterioration of Lead-Free Tin Solder at Low Temperatures – Fatigue Characterization of LeadFree Solders – Thermal Fatigue of Solder Joints, Fatigue Design of Lead-Free – Electronics – Fatigue Life Prediction Based on Field Profile, Fatigue Validation of Lead-Free Circuit – Flip-Chip Technology and Assembly process – card Assembly, surface mount technology – Management on e-waste recycle system construction, global collaboration and product disassemble technology.		
UNIT IV	**FLIP-CHIP ASSEMBLY AND BONDING FOR LEAD-FREE ELECTRONICS**	**9**
Flip-Chip Assembly Process – Placement and Under fill stage-FEM of Die stress – Gold stud Bump Bonding – Materials and Process Variations – Integrating Flip Chip into a Standard SMT Lead-Free Reflow soldering Techniques and Analytical Methods – Electro migration Analysis for Mean-Time-to Failure Calculations – Gold-Tin Solder Integrating Vertical-Cavity Surface Emitting Lasers onto Integrated Circuits – Design and Processing of Flip-Chip Bonding Structures – OptoElectronic Integration.		
UNIT V	**REAL TIME GREEN ELECTRONIC**	**9**
Lead-Free Electronic Design – Selection of the Package Type – Substrate or Die Attachment FR4 – Electrical Connections from Die to FR4 – Assess Impact of CTE Mismatch on Stress and Fatigue Life – Design Solder Balls for External Connection to PCB – Thermal Analysis of Flip-Chip Packaging – RLC for Flip-Chip Packages – Drop Test of Flip-Chip Packaging – Wei bull Distribution for Life Testing and Analysis of Test Data.		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. John X.Wang 'Green Electronics Manufacturing', CRC Press Indian Prentice Hall, 2012 2. Sammy G Shina, 'Green Electronics Design and Manufacturing' Mc Graw Hill 2008.		
REFERENCE BOOKS:		
1. Lee Goldberg, "Green Electronics/Green Bottom Line, Newnes Publications 2000		
ONLINE RESOURCES		
1. www.nptel.com		

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE161	**AUTOMOTIVE ELECTRONICS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

PREAMBLE: This subject serves as the prerequisite for many subjects such as basic electrical & electronics engineering, microprocessor & micro controller. It introduces students to cognitive learning in applied electrical & electronics and develops problem solving skills with both theoretical and engineering oriented problems.

PREREQUISITE COURSES: Basic Electronics Engineering and Microprocessor and Microcontrollers

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Learn concepts and develop basic skills necessary to diagnose automotive electrical problems
- Understand starting and charging, lighting systems, advanced automotive electrical systems, to include body electrical accessories, and basic computer control.
- Understand the instructions necessary to take the Automotive Service Excellence examination.

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 automotive and transmission systems.	K2
CO2	Explain the various functions of the sensors and actuators in the field of automotive applications	K2
CO3	Discuss about the various analog and digital control methods.	K2
CO4	Describe the Electronic control unit design.	K2
CO5	Explain the various interfacing techniques and applications of automotive 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	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	**FUNDAMENTAL OF AUTOMOTIVE ELECTRONICS**	**9**
Current trends in automotive electronic engine management system, electromagnetic interference suppression, electromagnetic compatibility, electronic dashboard instruments, onboard diagnostic system, security and warning system.		
UNIT II	**SENSOR TECHNOLOGIES IN AUTOMOTIVE**	**9**
Interfacing principles: Operation, topologies and limitations of all sensors covered in the above to in-vehicle processing or communications nodes. Interfacing electronics, Operational amplifier circuits, Instrumentation amplifiers, Comparators. Level shifting, Wave-shaping, Filters. Noise mechanisms and reduction. ADCs and DACs. Use of Actuators: Types, Working principle, Characteristics, limitations and use within the automotive context of each type		
UNIT III	**AUTOMOTIVE CONTROL SYSTEMS**	**9**
Control system approach in Automotive: Analog and Digital control methods, stability Augmentation, control augmentation, Transmission control, System components and Functions. Cruise control, traction control, actuator limiting, wind-up, gain scheduling, Adaptive control. Special Control Schemes: Vehicle braking fundamentals, Antilock Systems, Variable assist steering and steering control, Controls for Lighting, Wipers, Air conditions.		
UNIT IV	**ELECTRONIC CONTROL UNIT DESIGN**	**9**
Critical review of microprocessor, microcontroller and digital signal processor Development (overview of development within the automotive context). Architecture of 8/16 bit microcontrollers with emphasis on Ports, Timer/Counters, Interrupts, Watch-dog Timers, PWM, Memory requirement and Usage. High- level language programming.		
UNIT V	**AUTOMOTIVE COMMUNICATION SYSTEMS**	**9**
Communication interface with ECUs: Interfacing techniques and interfacing with VTU R-2015 infotainment gadgets. Relevance of internet protocols, such as TCP/IP for automotive applications. Wireless LANs standards, such as Bluetooth, IEEE802.11x. Communication protocols for automotive applications.		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. Williams. B.Ribbens, 'Understanding Automotive Electronics', 6th Edition, 2003, Elsevier Science, Newness Publication. 2. Robert Bosch, Automotive Electronics Handbook', John Wiley and Sons, 2004.		
REFERENCE BOOKS:		
1. James D Halderman, _'Automotive Electricity and Electronics', PHI Publication 2005. 2. Terence Rybak, Mark Steffka, 'Automotive Electromagnetic Compatibility (EMC)', Springer, 2004. 3. Allan Bonnick, 'Automotive Computer Controlled Systems: Diagnostic Tools and Techniques', Elsevier Science, 2001. 4. BehzadRazavi, 'Design of Analog CMOS Integrated Circuits' McGraw-Hill, 1999.		
ONLINE RESOURCES		
1. www.faadooengineers.com 2. www.nptelvideos.in		

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE162	**VEHICLE ELECTRONICS**	**2**	**0**	**2**	**3**

COURSE CATEGORY: Programme Elective

PREAMBLE: In this course, the students will learn about basic electronic modules used in modern vehicles and the networking architecture used to interconnect these modules.

PREREQUISITE COURSES: Nil

RELATED COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Understand the working of basic electronic circuits
- Know the specifications and applications of different sensors, actuators and switching devices
- Understand high level programming languages
- Design and implement numerous automotive electronic systems

COURSE OUTCOMES:

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

CO Nos.	Course Outcomes	Skill Level (Based on Dave's Taxonomy)
CO1	Interface various automotive sensors and actuators with given Microcontrollers	S4
CO2	Design an automotive electronic system for monitoring engine performance, infotainment and telematics.	S4
CO3	Recognize the appropriate protocols used in vehicle networking.	S2

CORRELATION OF COs WITH POs AND PSOs

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

COURSE CONTENT: THEORY

Introduction to basic electronics – Passive elements, Op-Amp, types of LED and LCD, logic gates, Mux, De-mux, driver circuits, ADC, DAC.

Sensors – Specifications and applications of ABS Sensor, wheel speed sensor, crank shaft position sensor, oxygen sensor, air flow sensor, tyre pressure sensor, engine coolant sensor, temperature sensor, brake fluid sensor, accelerometer, light sensor, Infra-Red, ultrasonic sensor.

Actuators – Specifications and applications of tyre inflator, AC unit compressor, windshield wiper, heating coil, lighting systems, airbag system, motors, valve.

Switching Devices – Specifications and applications of relays and switches – dip switch, push buttons, touch switch, toggle switch.

Automotive Electronic Systems – Antilock Braking System, Automatic Emergency Braking System, Engine Control System, Ignition Control and Start-Stop System, Heating and AC System, Vehicle Theft Security

System, Seat belt indication system, Camera and Ultrasonic sensor based Parking Assistance System, Vehicle navigation system, Vehicle telematics system.

High Level Programming – Features of Arduino and Raspberry Pi Boards, Basics of Embedded C and Python programming, programming using IDE – Arduino, MATLAB.

Networking – OSI layers, Bus architecture, LAN/WAN, CAN Protocol, FlexRay Protocol, Ethernet Protocol, AUTOSAR architecture

TOTAL: 30 HOURS

LIST OF EXPERIMENTS (15 HOURS)

1. LED and Push button interface using Arduino
2. LCD and Push button interface using Raspberry Pi
3. Design of turn light indicator system
4. Design of speed indication system
5. Design of image acquisition system
6. Design of stepper motor, servo motor and DC motor control

TEXTBOOKS:

1. Bosch Automotive Electrics and Automotive Electronics: Systems, Components and Hybrid Drive, Robert Bosch GmbH, Springer Vieweg, 2007.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE163	**OPTO ELECTRONIC DEVICES**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

PREAMBLE: Optoelectronic devices provide to learn different types of optical emission, detection and optoelectronic integrated circuits and their applications.

PREREQUISITE COURSES: Nil

RELATED COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Understand the fundamentals of optoelectronics
- Know different types of display devices and laser technology
- Know about the importance of photo detectors in communication system
- Understand functioning of various modulation circuits and switching devices
- Study different optoelectronic integrated circuits and their 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	Describe the fundamentals of optoelectronics	K2
CO2	Discuss the different types of display devices and operating principle of laser	K2
CO3	Classify the different types of photo detectors	K2
CO4	Explain about the modulators and switching devices	K2
CO5	Explain the integration methods, materials, OEIC transmitters receivers, guided wave devices and photonic integrated circuits	K2

CORRELATION OF COs WITH POs AND PSOs

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

COURSE CONTENT:		
UNIT I	**FUNDAMENTALS OF OPTOELECTRONICS**	**9**
Nature of Light, Wave Nature of Light: Polarization – Interference - Diffraction, Light Sources: Blackbody Radiation, Units of Light, Generation of Photo electronics, Elements of Solid State Physics - Quantum Mechanical Concept, Energy Bands in Solids, Semiconductors and Semiconductor Junction Devices		
UNIT II	**DISPLAY DEVICES AND LASER**	**9**
Luminescence, Photoluminescence Cathode luminescence, Cathode Ray Tube, Electro Luminescence, Injection Luminescence, LED: Materials - Commercial LED Materials – Construction - Drive circuitry, Plasma Display, Liquid Crystal Displays, Numeric Displays, Emission and Absorption of Radiation, Population Inversion, Laser losses, Laser Modes: Mode Locking- Active Mode Locking - Passive Mode Locking, Laser Applications		
UNIT III	**PHOTO DETECTORS**	**9**
Thermal Detectors - Thermoelectric Detectors - Bolometer - Pneumatic Detectors – Pyro electric Detectors, Photon Devices - Photo Emissive Devices - Vacuum Photodiodes - Photo Multipliers- Photon Counting Techniques - Photo Conductive Detectors, Detector Performance Parameters.		
UNIT IV	**MODULATION AND SWITCHING DEVICES**	**9**
Analog and Digital Modulation, Franz- Keldysh and Stark Effect Modulators, Quantum well Electro Absorption Modulators, Electro-Optic Modulators- Birefringence and Electro-Optic Effect - Kerr Modulators - Magneto Optic Modulators, Optical switching, and logic devices.		
UNIT V	**PHOTONICS & OPTOELECTRONIC INTEGRATED CIRCUITS**	**9**
Hybrid and Monolithic Integration, Applications of Optoelectronic Integrated Circuits, Materials and Processing for OEICs, Integrated Transmitters and Receivers- Front End Photo Receiver - PIN HBT Photo Receiver - OEIC Transmitter, Guided Wave Devices. Photonics, Photonic Integrated Circuits, Recent Developments in Photonic Integrated Circuits.		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Pallab Bhattacharya "'Semiconductor Opto Electronic Devices', Prentice Hall of India Pvt., Ltd., New Delhi, 2006.
2. J. Wilson and J.Haukes, 'Opto Electronics – An Introduction', Prentice Hall, 1995

REFERENCE BOOKS:

1. S C Gupta, 'Opto Electronic Devices and Systems', Prentice Hall of India, 2005.
2. Jasprit Singh, 'Opto Electronics – As Introduction to Materials and Devices', Mc Graw-Hill International Edition, 1998
3. B. E. A. Saleh and M. C. Teich, 'Fundamentals of Photonics', John Wiley & Sons, Inc., 2nd Ed. (2007).
4. J. Singh, 'Semiconductor Optoelectronics: Physics and Technology', McGraw-Hill Inc., 1995.

ONLINE RESOURCES

1. https://nptel.ac.in/courses/115/102/115102103/
2. https://nptel.ac.in/courses/117/101/117101054

COURSE CODE: 10212EE164	COURSE TITLE: ELECTRONICS CIRCUIT SIMULATION AND PCB DESIGN	L	T	P	C
		1	0	4	3

COURSE CATEGORY: Programme Elective

PREAMBLE: The course is aimed at making the students to understand electronic circuit simulation process for better understanding and designing of cost effective Printed Circuit Boards. Emphasizing the students to understand how to design a PCB layout of given circuit using available circuit simulation and PCB layout design CAD tools (free or licensed).

PREREQUISITE COURSES: Nil

RELATED COURSES: Analog Electronics, Linear Integrated Circuits

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Learn different circuit simulation tools used for electronic circuit simulation.
- Understand different PCB layout design and packages.
- Understand PCB manufacturing technology and assembly
- Design and fabricate PCB for a given circuit.

COURSE OUTCOMES:

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

CO Nos.	Course Outcomes	Skill Level (Based on Dave's Taxonomy)
CO1	Simulate and perform various analysis for the given Electronic Circuit.	S3
CO2	Design a PCB Layout for the given circuit.	S4
CO3	Fabricate the PCB and assemble the components.	S2

CORRELATION OF COs WITH POs AND PSOs

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

COURSE CONTENT: THEORY

Electronics Circuit Simulation

State the features of different circuit simulation tools (Open source or licensed) used for electronic circuit simulation. Different PCB layout design tools (Open source or License) used for PCB layout design. General terms and elements used in circuit simulation software. Assemble electronics circuit using circuit simulation software. Types of Circuit Analysis - Transient Analysis, Bias Point Analysis, Frequency Response.

PCB Layout Design

Terms used: net list file, back annotation, bill of material, foot print, PTH, track width, mil, etc. used in PCB layout design software. Place, route and generate the layout of given circuit using manual or auto routing using PCB layout design software. Raw Materials - Types of PCBs: Single layer - Double layer - Multi layer – Rigid – Flexible - Flex Rigid -High frequency - Aluminium Backed - Track Width Calculation - Layout Design - Back Annotation -Gerber File - NC Drill File - Fab and Assembly Drawings – Legend - Bill of Material. Packaging Trends - Package Classifications - Package Type and Characteristics: Through-Hole Mounting - Surface Mounting - Special Packages- Package Symbols and Codes. Symbols-Reference Designators Values and Attributes-Schematic Design Guidelines-Routing - Nodes – Joints - Design Error Check.

TOTAL: 15 HOURS

LIST OF EXPERIMENTS

S. No	CO Mapping	Practical Exercises
1.	CO1	Getting acquainted with simulation tool
2.	CO1	Design a Variable Power Supply Circuit using LM338/LM317
3.	CO1	Design a Hartley Oscillators Circuit and simulate its response
4.	CO1	Design an Astable Multivibrator Circuit and simulate its response
5.	CO1	Design and simulate response of Active and Passive Filter Circuits
6.	CO2	Getting acquainted with PCB layout tool

TOTAL: 30 HOURS

TEXTBOOKS:

1. Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards, Simon Monk; McGraw Hill Education (1 July 2014)
2. Complete PCB Design Using OrCAD Capture and PCB Editor, Kraig Mitzner Newnes; Pap/Cdr edition (28 May 2009), 2011, ISBN: 978-1-4493- 9357-1

List of Major Equipment/ Instrument/Software with Broad Specifications

1. Altium Designer (Licensed version)
2. Express PCB (Free version)
3. Eagle (Free version)
4. MultiSim (Student Version)
5. UtilBoard (Student Version)

ONLINE RESOURCES:

1. www.techdocs.altium.com/
2. www.ni.com (Multisim and Ultiboard - Academic version)
3. www.cadence.com (Orcade - Student version)
4. www.youtube.com (PCB Manufacturing Videos)

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE165	**MEDICAL ELECTRONICS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

PREAMBLE: Medical electronics provides the ideas and the basic knowledge of human anatomy, physiology and the need of electronics principle and applications of equipment's used in the medical field as well as introduce the concept of safety aspects for medical instruments.

PREREQUISITE COURSES: Linear integrated circuits, Biology for Engineers, Basic Electronics Engineering and Measurements & Instrumentation

RELATED COURSES: Internet of Things (IoT)

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Understand the basic concepts of human anatomy and physiology.
- Know the classification, application and specification of medical electronic equipments and electrodes like needle, pad and micro electrodes
- Understand the concept of various transducers, sensors and bio electrical machines like pressure transducers, flow sensor etc.,
- Learn about the patient monitoring systems and measurements like pulse, blood pressure.
- Study about the types of shocks like macro, micro shock and the concept of safety aspects

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 concepts of human anatomy and physiology	K2
CO2	Explain the principles of different medical electronic equipments	K2
CO3	Discuss the concept of various transducers, sensors and bio electrical machines	K2
CO4	Describe about the patient monitoring systems and measurements	K2
CO5	Discuss the importance of safety aspects in medical electronics and their 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	L	I			L							L		
CO2	L	M	M	L	M							M	L	
CO3	M	M	L	M										
CO4	L	L	M	M								M		
CO5	M	M	L	L	M				M		M	M		

COURSE CONTENT:		
UNIT I	**REVIEW OF ANATOMY AND PHYSIOLOGY**	**9**
Elementary ideas of cell structure, heart and circulatory system, central nervous system, muscle action, respiratory system, body temperature and reproduction system.		
UNIT II	**OVERVIEW OF MEDICAL ELECTRONICS EQUIPMENTS**	**9**
Classification, application and specifications of diagnostic, therapeutic and clinical laboratory equipment, method of operation of these instruments. Electrodes: bioelectric signals, bio electrodes, electrode tissue interface, contact impedance, types of electrodes, electrodes used for ECG, EEG, X-Ray & CT-Scan		
UNIT III	**TRANSDUCERS, SENSORS AND BIOELECTRICAL MACHINES**	**9**
Typical signals from physiological parameters, pressure transducer, flow transducer, temperature transducer, pulse sensor, respiration sensor, bio medical recorder block diagram description and application of following instruments, ECG Machine, EEG Machine, EMG Machine.		
UNIT IV	**APPLICATIONS OF BIOMEDICAL INSTRUMENTS**	**9**
Heart rate measurement, pulse rate measurement, respiration rate measurement, blood pressure measurement, principle of defibrillator and pace mark, use of microprocessor in patent monitoring.		
UNIT V	**SAFETY ASPECTS OF MEDICAL INSTRUMENTS**	**9**
Radiation safety instrumentation, radiation monitoring instruments, physiological effects due to 50 Hz current passage, gross current shock, micro current shock, special design from safety consideration, safety standards.		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Leislie Cromwell, “Biomedical instrumentation and measurement”, Prentice Hall of India, NewDelhi, 2007.
2. Khandpur, R.S., “Handbook of Biomedical Instrumentation”, TATA McGrawHill,New Delhi, 2003.

REFERENCE BOOKS:

1. Joseph J. Carr and John M. Brown, “Introduction to Biomedical equipment Technology”, John Wiley and Sons, New York, 2004.
2. Introduction to Biomedical Electronics by Edward J. Perkstein; Howard Bj, USA.

ONLINE RESOURCES

1. http://www.medicalelectronicsdesign.com
2. http://electronicsforu.com
3. http://engineering.careers360.com

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE201	**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:		
UNIT I	**FUZZY LOGIC**	**6**
Fuzzy sets- logic operations and relation, fuzzy decisions making, fuzzy inference systems, design of fuzzy logic controller.		
UNIT II	**ARTIFICIAL NEURAL NETWORKS**	**6**
Artificial neuron-Supervised and unsupervised learning-single layer perceptron, and multi-layer perceptron, back propagation neural network.		
UNIT III	**EVOLUTIONARY ALGORITHM**	**6**
Genetic algorithms: Introduction-genetic algorithm steps-selection, crossover, and mutation-Differential Evolution Algorithm		
UNIT IV	**SWARM INTELLIGENCE - I**	**6**
Particle Swarm Optimization (PSO)-Firefly Algorithm (FA), Artificial Bee Colony optimization (ABC) – Apllication to Electrical Engineering		
UNIT IV	**SWARM INTELLIGENCE - II**	**6**
Cat Swarm Optimization (CSO)-Bacterial Foraging Optimization(BFO), Ant Colony Optimization (ACO)		
		TOTAL: 30 PERIODS

LIST OF EXPERIMENTS (TOTAL: 30 PERIODS)

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) Application of Particle Swarm Optimization for optimization problem in electrical engineering
f) Application of Firefly Algorithm for optimization problems in electrical engineering
g) Application of Artificial Bee Colony optimization in electrical engineering optimization problems.
h) Application of Bacterial Foraging Optimization problems in electrical engineering
i) Application of Cat Swarm Optimization algorithm in electrical engineering optimization problems.
j) Application of Ant Colony Optimization in electrical engineering optimization problems.

TEXT BOOKS:

1. S.N.Sivanandam and S.N.Deepa, 'Principles of Soft Computing', Wiley India Pvt Ltd, 2011.
2. 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.

REFERENCE BOOKS:

1. S. Haykin, 'Neural Networks and Learning Machines', Prentice Hall, 2009.
2. S.Rajasekaran, G.A. Vijayalakshmi Pai,'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: **10212EE202**	COURSE TITLE: **SWITCH MODE POWER SUPPLY DESIGN AND DEVELOPMENT**	L	T	P	C
		2	**0**	**2**	**3**

COURSE CATEGORY: Programme 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 Electronics and Measurement Engineering, Electronic Circuits, and 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 OUTCOME:

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**	**6**
Introduction to SMPS-types-evolution- need of SMPS- Linear Regulator vs SMPS – Block diagram-advantages-Applications		
UNIT II	**COMPONENTS USED IN SMPS**	**6**
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**	**6**
Buck, Boost, Buck-Boost, Push-Pull, Fly back, Resonant, forward Converter- Operation.		
UNIT IV	**DESIGN OF SMPS**	**6**
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**	**6**
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: 30 PERIODS		

TEXT BOOKS:

1. Keith Billings, Taylor Morey, 'Switch Mode Power Supply Handbook', 3rd Edition, McGraw-Hill Education, New York, 2012.
2. Maniktala, Sanjaya (2006), 'Switching Power Supplies A to Z', Newnes /Elsevier, ISBN 0-7506-7970-0

REFERENCE BOOKS:

1. Abraham I. Pressman, Keith Billingss, Taylor Morey 'Switching Power Supply Design', 3rd Edition, New York: McGraw-Hill, 1999
2. ON Semiconductor (July 11, 2002), 'SWITCHMODE Power Supplies—Reference Manual and Design Guide' (PDF). Retrieved 2011-11-17.

LIST OF EXPERIMENTS **TOTAL: 30 PERIODS**

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:	COURSE TITLE:	L	T	P	C
10212EE203	**ELECTRICAL MACHINES**	**2**	**0**	**2**	**3**

COURSE CATEGORY: Programme Elective (Applicable only for Lateral Entry students)

PREAMBLE: In this course student will get expose on Electrical DC & AC machines concepts, methods of speed controls, and Applications

PREREQUISITE COURSES: Basic Electrical Engineering

RELATED COURSES: Electrical Machine Design

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- To gain the knowledge on the construction and principle of operation of DC generators.
- To analyse the performance characteristics of DC motors.
- To understand the concept, operation and equivalent circuit of transformers.
- To explain the concept of synchronous machines.
- To understand the operation and characteristics of single phase and poly phase induction motors.

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 construction and principle of operation of DC generators	K2
CO2	Analyse the performance characteristics of DC motors	K2
CO3	Understand the concept, operation and equivalent circuit of transformers.	K2
CO4	Explain the concept of synchronous machines.	K2
CO5	Understand the operation and characteristics of single phase and poly phase induction 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	H	M					L	M	L			H	M
CO2	H	H	M	M				L	M	L			H	M
CO3	H	H	M	L				L	M	L			H	M
CO4	H	H		L				L	M	L	M		H	M
CO5	H	H		H				L	M	L			H	M

COURSE CONTENT:		
UNIT I	**DC GENERATORS**	**6**
Construction and Principle, Methods of excitation, Magnetization and operating characteristics of generators, types, EMF equation - armature Reaction– Commutation – Methods of improving commutation.		
UNIT II	**DC MOTORS**	**6**
Principle of operation – Back EMF and torque equation – Characteristics and application of series, shunt and compound motors – starting of DC motors – Types of starters, Losses and efficiency.		
UNIT III	**TRANSFORMERS**	**6**
Theory and operation, EMF equation, Phasor diagram, equivalent circuit, open and short circuit tests. Performance estimation, Parallel operation, three phase transformer connections. Auto-transformers.		
UNIT IV	**SYNCHRONOUS MACHINES**	**6**
Alternators - types and constructional features - EMF equation, Concept of synchronous reactance, regulation by EMF and MMF methods, Synchronous motor starting and V curves.		
UNIT V	**INDUCTION MACHINES**	**6**
Poly phase Induction motors - types and constructional features - equivalent circuit - starting and speed control. Single phase induction motors -types and constructional features-principle of operation, double revolving field theory. Applications of induction motors.		
TOTAL: 30 PERIODS		

LIST OF EXPERIMENTS (30 PERIODS)

1. Open circuit and load characteristics of D.C self-excited shunt generator
2. Load characteristics of D.C shunt motor
3. Speed control of D.C shunt motor
4. Open circuit and short circuit tests on single phase Transformer
5. Load test on single phase transformer
6. Determination of voltage Regulation of three phase alternator by EMF and MMF methods
7. V and inverted V curves of Three Phase Synchronous Motor
8. Load test on three-phase induction motor
9. Speed control of three phase Slip ring Induction motor
10. Load test on single-phase induction motor

TEXT BOOKS:

1. Dr. P.S. Bhimbra, 'Electrical Machinery', Khanna Publications, 7th Edition, 2007.
2. Nagrath, I.J.and Kothari, D.P., 'Electrical Machines', Tata McGraw Hill Education Private Limited Publishing Company Ltd., 4th Edition, 2010.

REFERENCE BOOKS:

1. Arthur Eugene Fitzgerald and Charles Kingsley, 'Electric Machinery', Tata McGraw Hill Education Publications, 6th Edition, 2002.
2. Vincent Del Toro, 'Electrical Engineering Fundamentals', 2nd Edition, Prentice hall Publications, 2003.
3. Parkar Smith, N.N., 'Problems in Electrical Engineering', 9th Edition, CBS Publishers and Distributers, 1984.
4. https://elearn.nptel.ac.in/shop/nptel/electrical-machines/

COURSE CODE: **10212EE301**	COURSE TITLE: **VOLTAGE STABILIZER FABRICATION**	L	T	P	C
		0	**0**	**2**	**1**

COURSE CATEGORY: Programme 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 Electronics and Measurement Engineering

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 PERIODS

TEXT BOOKS:

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

REFERENCE BOOKS:

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

OPEN ELECTIVES

List of Courses (12 Credits)

.NO.	COURSE CODE	COURSE NAME	L	T	P	C
LECTURE COURSES						
1.	10213EE101	Neural Network and Fuzzy Logic Control	3	0	0	3
2.	10213EE102	Bio Medical Instrumentation	3	0	0	3
3.	10213EE103	Introduction to Automation	3	0	0	3
4.	10213EE104	Virtual Instrumentation	3	0	0	3
5.	10213EE105	Finite Element Analysis	3	0	0	3
6.	10213EE106	EMI and EMC Techniques	3	0	0	3
7.	10213EE107	Power Supply Quality	3	0	0	3
8.	10213EE108	Led Lighting	3	0	0	3
9.	10213EE109	Transducers and Sensors	3	0	0	3
10.	10213EE110	Signals and Systems	3	0	0	3
11.	10213EE111	Wearable Electronics	3	0	0	3
12.	10213EE112	Embedded System	3	0	0	3
13.	10213EE113	Estimation for Electrical Wiring	3	0	0	3
14.	10213EE114	Renewable Energy Systems	3	0	0	3
15.	10213EE115	Automotive Electrical and Electronics Systems	3	0	0	3
16.	10213EE116	Hybrid Electric Vehicles	3	0	0	3
17.	10213EE117	Introduction to Robotics	3	0	0	3
18.	10213EE118	Standards, Calibration, Testing and Maintenance of Electrical Equipment's	3	0	0	3
19.	10213EE119	Electrical Safety, Operation and Regulations	3	0	0	3
20.	10213EE120	Energy Conservation and Management	3	0	0	3
21.	10213EE121	Electrical Machines	3	0	0	3
22.	10213EE122	Industrial Electrical Systems	3	0	0	3
23.	10213EE123	Computer Aided Analysis of Electrical Apparatus	3	0	0	3
24.	10213EE124	Green Energy Resources	3	0	0	3
25.	10213EE125	Robotics and Automation	3	0	0	3
26.	10213EE126	Wind Energy Technology	3	0	0	3
27.	10213EE127	Electrical Safety and Safety Management	3	0	0	3
INTEGRATED COURSES						
28.	10213EE201	Switch Mode Power Supply Design and Development	2	0	2	3
LABORATORY COURSES						
29.	10213EE301	Voltage Stabilizer Fabrication	0	0	2	1

COURSE CODE: **10213EE101**	COURSE TITLE: **NEURAL NETWORK AND FUZZY LOGIC CONTROL**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Open Elective

PREAMBLE: This course Fuzzy Logic and Neural network require understand the concept of fuzziness involved in various systems and fuzzy set theory and neural network.

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- To cater the knowledge of Fuzzy Logic and Neural Networks in real time systems

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	Illustrate the concepts of feed forward neural networks	K2
C02	Explain the importance of feedback networks and specify the applications of neuro controller for various applications	K2
C03	Analyze and compare fuzzy set theory with conventional set theory	K3
C04	Explain fuzzy systems and the structure of fuzzy logic controller.	K2
C05	Identify various applications of fuzzy logic control to real time 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	M	H	M		L									
CO2	M	H	M		L									
CO3	M	H	M		L									
CO4	M	H	L		L									
CO5	M	H	L		L								M	M

COURSE CONTENT:		
UNIT I	**INTRODUCTION TO NEURAL NETWORKS**	**9**
Introduction – Biological neuron – Artificial neuron – Neuron modeling – Learning rules – Single layer – Multi layer feed forward network – Back propagation – Learning factors.		
UNIT II	**NEURAL NETWORKS FOR CONTROL**	**9**
Feedback networks – Hop field networks – Associative memories and Adaptive Resonance Theory – Applications of artificial neural network - Process identification – Neuro controller – Application to inverted pendulum problem.		
UNIT III	**FUZZY SYSTEMS**	**9**
Classical sets vs Fuzzy sets – Operation in fuzzy sets– NOT, AND and OR operators - Fuzzy relations – Fuzzification – Defuzzification – Fuzzy rules		
UNIT IV	**FUZZY LOGIC CONTROL**	**9**
Elements of Fuzzy logic Control - Membership function – Knowledge base – Decision-making logic – Adaptive fuzzy system - Introduction to neuro fuzzy controller		
UNIT V	**APPLICATION OF FLC**	**9**
Fuzzy logic control – Washing Machine - Inverted pendulum – Image processing – Home heating system – Blood pressure during anesthesia		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Jacek M. Zurada, 'Introduction to Artificial Neural Systems', Jaico Publishing Home, 2002.
2. Timothy J. Ross, 'Fuzzy Logic with Engineering Applications', Tata McGraw Hill, 1997.

REFERENCE BOOKS:

1. Laurance Fausett, Englewood cliffs, N.J., 'Fundamentals of Neural Networks', Pearson Education, 1992.
2. H.J. Zimmermann, 'Fuzzy Set Theory & its Applications' Allied Publication Ltd., 1996.
3. Simon Haykin, 'Neural Networks', Pearson Education, 2003.
4. John Yen & Reza Langari, 'Fuzzy Logic – Intelligence Control & Information', Pearson Education, New Delhi, 2003.

COURSE CODE: **10213EE102**	COURSE TITLE: **BIO MEDICAL INSTRUMENTATION**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Open 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 Electronics and Measurement Engineering

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- To provide an acquaintance of the physiology of the heart, lung, blood circulation and circulation respiration. Methods of different transducers used.
- To introduce the student to the various sensing and measurement devices of electrical origin.
- To provide the latest ideas on devices of non-electrical devices.
- To provide latest knowledge of Pulmonary Measurement & Bio Telemetry.
- To 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	Level of learning domain (Based on revised Bloom's taxonomy)
C01	To emphasize an acquaintance of the physiology of the heart, blood circulation and circulation respiration and the methods of different transducers used.	K2
C02	To demonstrate student to the various sensing and measurement devices of electrical origin and Instruments for checking safety parameters	K3
C03	To understand the latest ideas on devices of non-electrical devices.	K3
C04	To apply the latest knowledge of Pulmonary Measurement & Bio Telemetry.	K2
C05	To highlight the important and 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	L		H								M		L	M
CO2	M							L			L		L	
CO3			M								M			
CO4			H					M			M			
CO5			M										L	M

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

REFERENCE BOOKS:

1. Khandpur R.S, 'Handbook of Biomedical Instrumentation', Tata McGraw-Hill, New Delhi, 2nd Edition, 2003
2. John G. Webster, 'Medical Instrumentation Application and Design', John Wiley and Sons, New York, 1998.
3. Duane Knudson, 'Fundamentals of Biomechanics', Springer, 2nd Edition, 2007.
4. M.Arumugam, 'Bio-Medical Instrumentation', Anuradha Agencies, 2003.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE103	**INTRODUCTION TO AUTOMATION**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Open 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: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- 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		L	M	M	M									
CO2		H	M	H		M		L						
CO3		L	L	M		L		M						L
CO4		L	M	M	M									
CO5	L		L			M								M

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

TEXTBOOKS:

1. Frank Petruzella, 'Programmable Logic Controllers', 3rd Edition, Tata McGraw Hill Publications.
2. George Bolton, 'Programmable Logic Controllers', 5th Edition, Elsevier India Publications.

REFERENCE BOOKS:

1. Webb John W, Reis Ronald A 'Programmable Logic Controllers', PHI learning Pvt Ltd.
2. Hackworth 'Programmable Logic Controllers: Programming Methods and Applications' 1st Edition, Pearson India Publications.

COURSE CODE: **10213EE104**	COURSE TITLE: **VIRTUAL INSTRUMENTATION**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Open Elective

PREAMBLE : To study the concept of virtual instrumentation using software language

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- To study the principles and techniques of windows programming using MFC, procedures, resources, controls and database programming through the visual languages, Visual C++ and Visual Basic.

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	Comprehend the concept of analog signals in digital domain.	K2
CO2	Apply Calibration and Resolution for analog inputs and outputs using DAQ.	K3
CO3	Interface the external instruments to PC by selecting the appropriate on communication bus.	K3
CO4	Gain a vast knowledge of graphical programming techniques.	K2
CO5	Develop program for simple applications using VI	K5

CORRELATION OF COs WITH POs AND PSOs

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

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

TEXTBOOKS:

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.

REFERENCE BOOKS:

1. Robert H. Bishop, 'Learning with Labview', Prentice Hall of India, 2003.
2. Kevin James, 'PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control', Newnes, 2000.
3. Gary W. Johnson, Richard Jennings, 'Lab-view Graphical Programming', McGraw-Hill Professional Publishing, 2001.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE105	**FINITE ELEMENT ANALYSIS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Open Elective

PREAMBLE : This course will explore the basic concept of discrete and continuous element analysis

COURSE EDUCATIONAL OBJECTIVES:

- To introduce the concept of numerical analysis of structural components

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	Understand the criteria of finite element method	K2
CO2	Explain about the basics of discrete elements	K2
CO3	Describe about the continuum elements	K2
CO4	Explain about the applications of isoperimetric elements	K2
CO5	Understand the applications to other field problems	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						L							
CO2			H		H	L				H				
CO3	L	H	H				H		H					
CO4	L	L			M	M		M						
CO5	M		H		H								M	M

COURSE CONTENT:

UNIT I	INTRODUCTION	9

Review of basic analysis – Stiffness and Flexibility matrix for simple cases – Governing equation and convergence criteria of finite element method.

UNIT II	DISCRETE ELEMENTS	9

Bar, Frame, beam elements – Application to static, dynamic and stability analysis.

UNIT III	CONTINUUM ELEMENTS	9

Various types of 2-D-elements Application to plane stress, plane strain and axisymmetric problems

UNIT IV	ISOPARAMETRIC ELEMENTS	9
Applications to two and three-dimensional problems		
UNIT V	**FIELD PROBLEM**	**9**
Applications to other field problems like heat transfer and fluid flow.		
		TOTAL: 45 PERIODS

TEXTBOOKS:

1. Tirupathi.R. Chandrapatha and Ashok D. Belegundu, 'Introduction to Finite Elements in Engineering', Prentice Hall India, 3rd Edition, 2003.
2. Reddy J.N. 'An Introduction to Finite Element Method', McGraw-Hill, 2000.

REFERENCE BOOKS:

1. Krishnamurthy, C.S., 'Finite Element Analysis', Tata McGraw-Hill, 2000.
2. Bathe, K.J. and Wilson, E.L., 'Numerical Methods in Finite Elements Analysis', Prentice Hall of India, 1985.

COURSE CODE: 10213EE106	COURSE TITLE: EMI & EMC TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE CATEGORY: Open Elective

PREAMBLE: This course will enable the students to understand power quality issues in power systems.

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- To acquire knowledge of non linear loads.
- To acquire knowledge of different converter circuits used in power systems
- To walk around the various applications and stability analysis in power systems.

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	Understand the basic idea behind EMI and EMC	K2
CO2	Gain knowledge about grounding techniques.	K2
CO3	Gain knowledge on the importance of shielding.	K2
CO4	Understand the concepts of digital circuit noise.	K2
CO5	Gain knowledge on industrial and government standards for EMI	K2

CORRELATION OF COs WITH POs AND PSOs

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

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		

TEXTBOOKS:

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. 1987.

REFERENCE BOOKS:

1. Bridges, J.E Milleta J. and Ricketts.L.W, 'EMP Radiation and Protective Techniques', John Wiley and Sons, USA 1976.
2. IEEE National Symposium on 'Electromagnetic Compatibility', IEEE, 445, Hoes Lane, Piscataiway, NJ 08855.

COURSE CODE: **10213EE107**	COURSE TITLE: **POWER SUPPLY QUALITY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE CATEGORY: Open Elective

PREAMBLE: This course provides knowledge on need for power supply quality, factors affecting the power quality, their sources, effects and solutions.

PRE-REQUISITES : Basic Electrical Engineering

COURSE EDUCATIONAL OBJECTIVES:

To impart knowledge on

- To provide knowledge on importance of power supply quality.
- To educate the power quality phenomena, sources and its effects.
- To understand the role of power quality standards and charts.
- To demonstrate the types of linear and nonlinear loads.
- To brief about power conditioning devices and monitoring systems.

COURSE OUTCOMES:

Upon the 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 importance of Power Quality	K2
CO2	Describe about power quality problems, categories, causes and its effects	K2
CO3	Interpret the role of power quality standards and charts	K2
CO4	Demonstrate the various types of linear and nonlinear loads	K2
CO5	Summarize Power Conditioning devices and Power Quality Monitoring 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			M										L	
CO2			M										M	L
CO3			M											
CO4	L		H									H		
CO5			H	H								M	L	L

COURSE CONTENTS		
UNIT I	**INTRODUCTION**	**9**
Evolution of Power Quality, Definition – Importance of Power Quality, Voltage Quality, Voltage Versus Current Distortion, Sources of Power Quality Problems, Economic impacts		
UNIT II	**POWER QUALITY PHENOMENA**	**9**
Categories of Power Quality: Transients, Steady State Variations, Short Duration and Long Duration Voltage Variations, Sags, Swells, Interruptions, Voltage Unbalance, Waveform Distortion, Harmonics, Voltage Fluctuations, Flicker, Power Frequency Variation. Causes, Effects and Solutions		
UNIT III	**STANDARDS AND CHARTS**	**9**
Need and Role of PQ standards, Indian Standards, International Power Quality Standards and Charts: IEEE standards, IEC Standards, Total harmonics distortion (THD), Power acceptability curves: Computer Business Equipment Manufacturers Association (CBEMA) curve, Semiconductor Equipment and Materials International group (SEMI) curve, Information Technology Industry Council (ITIC) curve.		
UNIT IV	**LINEAR AND NON LINEAR LOADS**	**9**
Fluorescent lighting, Fans, Computer Loads, Switch Mode Power Supplies (SMPS), Uninterrupted Power Supply (UPS), Electronic Ballasts, microprocessor based control systems (PCs, PLCs), Inverters, Battery load, Battery Chargers, Biomedical devices, Network devices		
UNIT V	**CASE STUDY**	**9**
Simulation of Power Quality Problems using PQ teaching toy software. Introduction to Mathematical transforms for PQ analysis, Overview of Power Conditioning Devices and Mitigating Equipments. Importance of proper wiring and grounding. Outline of Power Quality Monitoring Systems.		
		TOTAL: 45 PERIODS

TEXTBOOKS:

1. Roger C. Dugan, Mark F. McGranaghan, Surya Santoso and H.WayneBeaty, 'Electrical Power Systems Quality', McGraw Hill, 2003.
2. Math H.J.Bollen, 'Understanding Power Quality Problems-Voltage Sag & Interruptions', IEEE Press,2000

REFERENCE BOOKS:

1. G.T. Heydt, 'Electric Power Quality', 2nd Edition. Circle Publications, 1994.
2. Arrillaga, N.R. Watson, S. Chen, 'Power System Quality Assessment', Wiley, 1999.

EXTENSIVE READING:

1. Electric Power Quality by Surajit Chattopadhyay
(http://www.springer.com/engineering/energy+technology/book/978-94-007-0634-7)
2. Power Quality byC. Sankaran
(www.fer.unizg.hr/_download/repository/Power_Quality.pdf)
3. Power Quality in Electrical Systems byAlexander Kusko, Marc T. Thompson
(http://www.lybrary.com/power-quality-in-electrical-systems-p-56147.html)

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE108	**LED LIGHTING**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Open 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: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- State the need for Illumination
- 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	Discuss and design the types and working of power electronic circuits used in LED technology	K3
CO4	Develop the Lighting control strategies, building lighting control systems and applications	K3
CO5	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				
CO4					M									
CO5														

COURSE CONTENT:		
UNIT I	**LIGHT AND ILLUMINATION**	**9**
Basics about Light: Electromagnetic Spectrum, Visible Spectrum, Wavelength, Characterisations, 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

TEXTBOOKS:

1. Amar K.Ganguly 'Optoelectronic Devices and Circuits, Theory and Applications', Narosa Publishing House.
2. Dr.P.S.Bimbhra 'Power Electronics', 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. Anil Valia 'Light Design', Published by Mili Jain.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE109	**TRANSDUCERS AND SENSORS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Open Elective

PREAMBLE: To enable the students to select and design suitable instruments to meet the requirements of industrial; application and various transducers, sensors used for the measurements of various physical quantities.

PREREQUISITES: Basic Electrical Engineering

COURSE EDUCATIONAL OBJECTIVES:

To impart knowledge on

- To understand the structural and functional principles of sensors and transducers used for various physical and nonelectric quantities.
- To explain the principles of operation of the sensor parameters
- To understand the knowledge about the implementation of sensors and transducers into a control system structure.

COURSE OUTCOMES:

Upon the completion of the course students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's taxonomy)
CO1	Classify and describe various transducers which are used for measuring various parameter like displacement, temperature etc.	K2
CO2	Understand the static and dynamics characteristics of transducers	K2
CO3	Identify the type of transducers used for various application	K2
CO4	Understand the virtual instrumentation for various data acquisition	K2
CO5	Understand the types sensor used for various 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	H	H	L						L			
CO2	M	L	H	M	L						L			
CO3	H	L	H	M	L						M			L
CO4	H	L	H	M	L						M			
CO5	H	H	H	M	M						H			L

COURSE CONTENTS		
UNIT I	**INTRODUCTION**	**9**
Basic method of measurement, generalized scheme for measurement systems, units and standards, errors, classification of errors, error analysis, statistical methods, sensor, transducer , classification of transducers, basic requirement of transducers.		
UNIT II	**CHARACTERISTICS OF TRANSDUCERS**	**9**
Static characteristics, dynamic characteristics, mathematical model of transducer, zero, first order and second order transducers – response to step, ramp and sinusoidal inputs.		
UNIT III	**RESISTIVE, INDUCTIVE AND CAPACITANCE TRANSDUCERS**	**9**
Potentiometer, Strain gauge, LVDT, variable reluctance transducers, Proximity transducers, capacitive transducer, Capacitor microphone, capacitive thickness Transducers, capacitive strain transducers, hall effect transducer, fiber optic transducer and its application.		
UNIT IV	**DATA ACQUISITION**	**9**
Types of transducer, signals, signal conditioning, DAQ hardware, analog inputs and outputs, DAQ software architecture, selection and configuration data acquisition device, components of computer based measurement system		
UNIT V	**SENSORS**	**9**
Introduction to sensors, types of sensor, smart sensors, fiber optic sensors, MEMS, nano sensors, Ultrasonic Sensors, Thin Film Sensors, Liquid Level Sensors, typical application of sensors		
		TOTAL: 45 PERIODS

TEXTBOOKS:

1. Sawhney. A.K**,** 'A Course in Electrical and Electronics Measurements and Instrumentation', 18th Edition, Dhanpat Rai & Company Private Limited, 2007.
2. Renganathan. S, 'Transducer Engineering', Allied Publishers, Chennai, 2003.

REFERENCE BOOKS:

1. Murthy.D.V.S, 'Transducers and Instrumentation', Prentice Hall of India,2001
2. Doebelin. E.A, 'Measurement Systems – Applications and Desig', Tata McGraw Hill, New York, 2000.
3. Patranabis. D, 'Sensors and Transducers', Prentice Hall of India, 1999.
4. John. P, Bentley, 'Principles of Measurement Systems', III Edition, Pearson Education, 2000.
5. Doebelin. E.A, 'Measurement Systems – Applications and Design', Tata McGraw Hill, New York, 2000.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE110	**SIGNALS AND SYSTEMS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Open 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

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- 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	Understand the concept of sampling	K2
CO5	Apply the Z-Transforms technique to DT signal	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													
CO2	H							H		M	H			
CO3	H			H				H		M	H			
CO4		M	M	L		M		M		M				
CO5										H				

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 Coeffificients-Symmetry Conditions – Discrete time Fourier Series-Application of Fourier Series to networks		
UNIT III	**FOURIER TRANSFORMS**	**9**
Representation of Aperiodic 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

TEXTBOOKS:

1. 1. B. P. Lathi, 'Principles of Linear Systems and Signals', 2nd 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.

COURSE CODE: **10213EE111**	COURSE TITLE: **WEARABLE ELECTRONICS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Open Elective

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

PREREQUISITE COURSES: Basic Electrical Engineering

COURSE EDUCATIONAL OBJECTIVES :

- To learn about wearable technology and different interfacing technologies.
- To understand about electro statically generated nano fibres.
- To describe about sensing fabric and understand smart fabric for health care etc.
- To discuss strain sensor in wearable devices.
- To study 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	Know the concept of wearable technology and different interfacing methodologies	K2
CO2	Discuss about production of Nano fibres	K2
CO3	Understand about sensing fabric, actuating fabrics etc.	K2
CO4	Discuss about strain sensors used in wearable devices	K2
CO5	Understand about application 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			
CO2	L	H	L	H	H	H	H				L			
CO3	H		H					M	L	M				
CO4	L							M	M	M				
CO5	L		M		M			H	M	M				

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-Electro spinning process-Background-Controlling the diameter of the fibre-Formation of yarns and fabrics-Electro active nanofibers - Inherently conductive polymers and blends-Nanocomposites-Pyrolysis and coating of nanofibres		
UNIT III	**ELECTROACTIVE FABRICS AND WEARABLE MAN–MACHINEINTERFACES**	**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		
UNITV	**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

TEXTBOOKS:

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:	COURSE TITLE:	L	T	P	C
10213EE112	**EMBEDDED SYSTEM**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Open 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: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- To teach students all aspects of the design and development of an embedded system, including hardware and embedded software development.
- To learn and understand the characteristics of embedded systems and its architectures.
- Understanding and experience of state of – the - practice industrial embedded systems and intelligent embedded system development.
- To 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.	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	H	M			H	L	M	M	L		
CO2	M	M	M	H	M			H	L	M	M	L		
CO3	M	L	L	H	M			H		M	M			
CO4	M	M	M	H	M			H	L	M	M	L	M	M
CO5	M	M	M	H	M			H	L	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.

REFERENCE BOOKS:

1. R. Mall, 'Real Time Systems Theory and Practice', Pearson, 2008.
2. Jean J.Labrosse, 'Embedded System Building Blocks', CMP books, 2nd Edition, 1999.
3. T. Noergaard, 'Embedded Systems Architecture: A Comprehensive Guide for Engineers and Programmers', Newness, 2005.
4. Dr. Prasad, 'Embedded Real Time System', Wiley Dreamtech, 2004.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE113	**ESTIMATION FOR ELECTRICAL WIRING**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Open Elective

PREAMBLE: To understand the methods/procedure of estimating, tendering/ contracting are desired. Knowledge of IE rules for different types of electrical Installation, their planning considerations equips the students with the capability to plan and prepare different Installation projects.

PREREQUISITE COURSES: Basic Electrical and Electronics Engineering.

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- To learn the symbolic representation of the wiring materials.
- To learn quantity and cost of the material for IE Act.
- To teach specifications of electrical wiring.
- To understand about the different types of wrings
- To understand quantity and cost of the material for a electrical projects.

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	Explain the symbolic representation of the wiring materials.	K3
C02	Explain, estimate of quantity and cost of the material for the following IE Act.	K2
C03	Describe about the specifications of electrical wiring	K1
C04	Explain about the different types of wrings	K2
C05	Describe the quantity and cost of the material for a electrical project following IE Act.	K1

CORRELATION OF COs WITH POs AND PSOs

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

COURSE CONTENT:		
UNIT I	**ELECTRICAL SYMBOLS**	**9**
Main fuse board with switches (lighting) -Distribution fuse-board with switches (lighting) -Main fuse-board with switches (power) -Distribution fuse-board with switches (power) - Main witches for Lighting and power. Junction of conductors-Line Existing - Line Proposed - OH line UG cable – Fault Line crossing - Socket outlet 5 amps - Socket outlet with switch 5 amps Socket outlet 15 amps - Socket outlet with switch 15 amps.		
UNIT II	**INDIAN ELECTRICITY RULES**	**9**
Rule 28 Voltage, Rule 30 Service Lines and apparatus on consumer premises, Rule 31 Cut-out on consumer's premises, Rule 46 Periodical inspections and testing of consumer's installation, Rule 47 Testing of consumer's installation.		
UNIT III	**SPECIFICATION OF ELECTRICAL ITEMS**	**9**
Switches - Main Switches - Sockets - Switch boards - Wall socket - Fuse units - Lamp Holders - Ceiling rose - Distribution boxes - Miniature Circuit Breaker - Earth Leakage Circuit Breaker - Ceiling fan - Electronic fan regulator - Storage type Water Heater – Immersion Heater – Wires and Cables (PVC, VIR, Weather Proof) - UG Cable (LT and HT) - Copper conductor sizes and rating – Earth wires. Lamps: Incandescent lamp, fluorescent lamp, Sodium vapour lamp, High Pressure Mercury Vapour lamp, Halogen lamp - Neon tube/lamp		
UNIT IV	**SYSTEMS OF INTERNAL WIRING, WIRE SIZE, FUSE, SHOCK, EARTHING, AND TESTING OF INSTALLATION**	**9**
Wiring systems – Types of wiring – points to be considered for selection of wiring -comparison – Looping back system and Joint box system and tree system – Position of switches, cutouts, main switch board, sub-distribution boards. Considerations for selecting wire size – size of conductors /cable used for Domestic installation, Service connection, Distributors - Power rating of some important households electrical appliances Materials used as fuse element – Selection of fuse wire - types of fuses – difference between circuit breaker and fuse – why fuse is not used in the neutral – table for sizes of fuse wire. Electric shock – Effects of electric shock – factors influencing the electric shock - Precautions against electric shock – cure of shock - Treatment for electric shock - artificial respiration - fire hazards due to electricity.		
UNIT V	**DOMESTIC, COMMERCIAL AND INDUSTRIAL INSTALLATION ESTIMATES**	**9**
Conditions and Requirements for Domestic, Commercial and Industrial Installation – steps to be followed in preparing electrical estimate (domestic, industrial and agricultural installation), Estimate the quantity of material required for Residential single bed room Flat (1BHK).Industrial power wiring having 4 or 5 machines, School building having 3 class rooms, Primary Health Centre having minimum 6 rooms, Lighting scheme of a party hall having minimum 20 twin TL fittings.		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. Gupta 'Electrical Estimating and Costing' (PDF). 2. Dr.S.L.Uppal 'Electrical Wiring, Estimating & Costing' (PDF).		
REFERENCE BOOKS:		
1. C.R.Dargon, 'Electrical Drawing & Estimating'. 2. K.B.Raina and S.K.Bhattacharya 'Electrical Engineering'.		

COURSE CODE: **10213EE114**	COURSE TITLE: **RENEWABLE ENERGY SYSTEMS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Open 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

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- 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	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											L	L	L	L
CO2		H	H					M	M					
CO3		H												
CO4			H		H	L	H				L	L		
CO5		L			L			M	M		L	L	L	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
2. Sukhatme S P and Nayak J K, 'Solar Energy - Principles of Thermal Collection and Storage', Tata McGraw Hill, 2008.

REFERENCE BOOKS:

1. Kothari P, K C Singal and Rakesh Ranjan, 'Renewable Energy Sources and Emerging Technologies', PHI Pvt. Ltd., New Delhi, 2008.
2. Bent Sorensen, 'Renewable Energy', Academic Press, 2004.
3. Abbasi S A and NaseemaAbbasi, 'Renewable Energy Sources and their Environmental Impact', PHI Private Limited, 2001.
4. Wakil M M H, 'Power Plant Technology', McGraw Hill, 1984.

COURSE CODE: **10213EE115**	COURSE TITLE: **AUTOMOTIVE ELECTRICAL & ELECTRONICS SYSTEMS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Open 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 Electrical Engineering

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- To introduce the basic layout of an automotive electrical system.
- To introduce about the Starting and Charging systems of a vehicle.
- To introduce about the Sensors and Actuators used in an Automobile.
- To introduce about the control systems within a vehicle.
- To 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.	K1
C02	Troubleshoot the problems behind the drives employed in a vehicle.	K2
C03	Analyze the different sensor arrangements in a vehicle	K1
C04	Differentiate the various control strategies on a vehicle	K1
C05	Manage an engine and understand it's input parameters for the ECU.	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							L						
CO2								M			H			
CO3						L								
CO4								M					M	
CO5						H					H		M	

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. William B. Ribbens, Norman P. Mansour 'Understanding Automotive Electronics', Elsevier, 2012.
2. P L Kohli 'Automotive Electrical Equipment' Tata McGraw-Hill Education, 2004.

REFERENCE BOOKS:

1. Tom Denton 'Automobile Electrical and Electronics Systems', Elsevier, 4th Edition (April 9, 2012)
2. Robert Bosch 'Automotive Handbook' SAE- 2011 Edition I.
3. Dr.Kirpal Singh 'Automobile Engineering', Standard Publishers, Vol- 1 and Vol- 2, 2012.
4. Judge A.W. 'Modern Electrical Equipment of Automobiles' Chapman and Hall, London, 2011.
5. R.K. Jurgen 'Automotive Electronics Handbook' McGraw Hill, 2nd Edition, 2010.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE116	**HYBRID ELECTRIC VEHICLES**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Open Elective

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

PREREQUISITE COURSES: Basic Electrical Engineering, Basic Electronics Engineering

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- An overview of the vehicle propulsion principle.
- An understanding of the electric vehicles and its powertrains.
- The fundamental knowledge on hybrid electric vehicles.
- An elaborate knowledge on regenerative braking.
- Broad analytical knowledge on advantages of electric vehicles on 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	K1
C02	Demonstrate the structure of an electric vehicle	K2
C03	Illustrate the working principle of a Hybrid Electric Vehicle	K2
C04	Identify and solve the problems in regenerative braking	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						L								
CO2								H						
CO3								H						
CO4			M			M								
CO5										H			L	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 Drivetrains-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.
2. Larminie, James, and John Lowry. 'Electric Vehicle Technology Explained', John Wiley&Sons, Ltd., 2003.

REFERENCE BOOKS:

1. Ehsani, Mehrdad, YiminGao, and Ali Emadi 'Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design', CRC Press, 2009.
2. Emadi, Ali, 'Handbook of Automotive Power Electronics and Motor Drives', CRC Press, 2005.
3. Soylu, Seref, 'Electric Vehicles: The Benefits and Barriers', InTech, 2011.
4. Soylu, Seref. 'Electric Vehicles–Modelling and Simulations' InTech Europe, Rijeka, Croatia, 2011.

COURSE CODE: **10213EE117**	COURSE TITLE: **INTRODUCTION TO ROBOTICS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Open Elective

PREAMBLE: This course will help the students to study the basic concepts of robotics and their design.

PREREQUISITE COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- Robotics is the engineering science and technology of robots, and their design, manufacture, application, and structural disposition.

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	Introduction about basic components and types of robots	K1
C02	Analysis of robot motion and control	K2
C03	Basic concepts of Artificial intelligence	K2
C04	Robot programming introduction	K2
C05	Applications of robotics	K2

CORRELATION OF COs WITH POs AND PSOs

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

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. MikellP.Groover, Michellwein,Roger N. Nagal and Nicholas G.Ordey, 'Industrial Robotics, technology, Programming and applications' Mc Graw Hill, 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 Introduction", Holt – Saunders International Edition, Japan, 1985.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE118	**STANDARDS, CALIBRATION, TESTING & MAINTENANCE OF ELECTRICAL EQUIPMENTS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Open Elective

PREAMBLE: This course introduces the students about the electrical safety operations and IEEE standards.

PREREQUISITE COURSES: Basic Electrical Engineering

COURSE EDUCATIONAL OBJECTIVES:

- The objectives of the course are to make the students,
- To develop Calibration Professionals capable of handling calibration laboratories & managing calibration system in an organization
- Understand Measurement Units, Standards, Systems, Testing & Calibration, Traceability & Uncertainty, Mathematics &and Applied Statistics
- Understanding standards ISO 9001 & 17025 requirements with regard to Laboratory Management for implementation & maintenance of accreditation

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	Measurement standards and its units	K2
CO2	Measurement methods and characteristics of measurements	K2
CO3	Calibration procedures and methods of calibration	K2
CO4	Basics of Statistics and applied mathematics	K2
CO5	To estimate uncertainty & reporting about uncertainty	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					L	M			L		
CO2	L		M	M				L	M					
CO3			M	L				L	M					
CO4				L				L			M			
CO5	M			H				L	M					

COURSE CONTENT:

UNIT I	GENERAL METROLOGY	9

Global metrology scenario, Measurement units, Measurement standards & Measurement traceability.

UNIT II	**MEASUREMENT SYSTEM**	**9**
Measurement methods, Measurement data & characteristics of measurements, T&ME specifications, Primary error sources, Measurement systems and capabilities & Measurement assurance programs		
UNIT III	**CALIBRATION SYSTEM**	**9**
Calibration procedures & methods, Industry practices & regulations, Control of calibration environment, Calibration processes, Manual & automated calibration, Calibration results & reporting and Records & records management		
UNIT IV	**APPLIED MATHEMATICS & STATISTICS**	**9**
Technical & Applied mathematics, QC tools and Applied statistics		
UNIT V	**UNCERTAINTY**	**9**
Uncertainty management, Uncertainty components, Estimation of uncertainty, Evaluation of uncertainty & Reporting uncertainty		
		TOTAL: 45 PERIODS

REFERENCE BOOKS:

1. B.V.S Rao 'Operation and Maintenance of Electrical Equipment's' Media Promoters and Publishers, Volume1.
2. Alan S Morris 'Measurement and Instrumentation: Theory and Application' 2nd Edition, Elsevier, 2015.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE119	**ELECTRICAL SAFETY, OPERATION & REGULATIONS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Open Elective

PREAMBLE: This course introduces the Electrical safety operations and IEEE Standards.

PREREQUISITE COURSES: Basic Electrical Engineering

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- Study about electrical safety and equipment required to maintain safety.
- Details about Protection guidelines and importance of earthing.
- To get knowledge about Indian electricity rules and regulations and IEEE standards for electrical safety.

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	Basics of electrical safety	K2
CO2	Protection procedures and earthing requirements	K2
CO3	Safety requirements while doing electrical works	K2
CO4	Safe operating procedures, energy auditing basics	K2
CO5	Regulations and standards related to electrical safety	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					L	M			L		
CO2	L		M	M				L	M					
CO3			M	L				L	M					
CO4				L				L			M			
CO5	M			H				L	M					

COURSE CONTENT:

UNIT I	ELECTRICAL SAFETY	9

Safety of the Self, Safety of the equipments, Safety of the public.

UNIT II	**PROTECTION PROCEDURES AND EARTHING**	**9**
Guidelines, General guidelines on earthing and protection		
UNIT III	**SAFETY OPERATIONS**	**9**
Sign boards, Tagging system and procedures.		
UNIT IV	**SAFE OPERATING PROCEDURES**	**9**
Safe operating procedures, Case studies and, Audit basics.		
UNIT V	**REGULATIONS**	**9**
IS, IEEE standards, Indian Electricity rules and regulations		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. HSC- A Practical Guide Vol. 1 To 4, National Safety Council, India.
2. IS 5216 (Part I)- 1982, 'Recommendations on Safety Procedures and Practices in Electric Work'.

REFERENCE BOOKS:

1. SP 30 -1985 Special Publication-National Electric Code, 'Section-14: Electric Aspects of Building Services'.
2. IEEE Standard 902.
3. Indian Electricity Rules: IE Rules1956.
4. Quality Control Order 2003: GO India Ministry of Commerce & Industry.
5. IS 8437: Guide on Current Through Human Body
6. Related technical papers of present interest.
7. Blake R P, Industrial Safety, Prentice, Englewood Cliffs ,1963

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE120	**ENERGY CONSERVATION AND MANAGEMENT**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Open Elective

PREAMBLE: This course gives a brief introduction about electrical energy conservation and mitigation.

PREREQUISITE COURSES: Basic Electrical Engineering

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- To understand the basics about energy engineering and management.
- To get knowledge about EB and efficient way to use electrical energy.
- Basics about thermal engineering and equipment related to thermal engineering.
- Quantity of electrical energy utilized by different components.

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	Introduction about energy consumption, energy management, energy auditing.	K2
CO2	Energy consumption and capacity of different electrical equipment's	K2
CO3	Thermal stability and analysis of electrical equipment's	K2
CO4	Energy conservation in major electrical devices	K2
CO5	Economical oriented energy management 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			M					L	M			L		
CO2	L		M	M				L	M					
CO3			M	L				L	M					
CO4				L				L			M			
CO5	M			H				L	M					

COURSE CONTENT:		
UNIT I	**INTRODUCTION**	**9**
Energy – Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization –Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.		
UNIT II	**ELECTRICAL SYSTEMS**	**9**
Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors – Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination		
UNIT III	**THERMAL SYSTEMS**	**9**
Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories		
UNIT IV	**ENERGY CONSERVATION IN MAJOR UTILITIES**	**9**
Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G.		
UNIT V	**ECONOMICS**	**9**
Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Energy Manager Training Manual (4 Volumes) available at www.energymanager training.com, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.
2. Witte. L.C., P.S. Schmidt, D.R. Brown, 'Industrial Energy Management and Utilisation' Hemisphere Publ, Washington, 1988.

REFERENCE BOOKS:

1. Callaghn, P.W. 'Design and Management for Energy Conservation', Pergamon Press, Oxford, 1981.
2. Dryden. I.G.C., 'The Efficient Use of Energy' Butterworths, London, 1982
3. Turner. W.C., 'Energy Management Hand Book', Wiley, New York, 1982.
4. Murphy. W.R. and G. Mc KAY, 'Energy Management', Butterworths, London 1987.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE121	**ELECTRICAL MACHINES**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Open Elective

PREAMBLE: In this course student will get expose basic Electrical DC & AC machines concepts, and methods of speed controls, Applications as stepper & Brushless motors.

PREREQUISITE COURSES: Basic Electrical Engineering

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- To provide knowledge on construction and operation of DC machines.
- To provide Theory and operation, phase diagram of transformer.
- To understand the Concept of synchronous machines.
- To understand the poly phase Induction motor principle.
- To provide knowledge on single phase Induction motor principle.

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 Construction and operation of DC Machines	K2
CO2	Explain the Theory and operation, phasor diagram of transformer	K2
CO3	Explain the Concept of synchronous machines	K2
CO4	Illustrate the three phase Induction motor principle	K2
CO5	Illustrate the single phase Induction motor principle	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					L	M			L		
CO2	L		M	M				L	M					
CO3			M	L				L	M					
CO4				L				L			M			
CO5	M			H				L	M					

COURSE CONTENT:		
UNIT I	**DC MACHINES**	**9**
Construction of DC Machines, Methods of excitation, Magnetization and operating characteristics of generators, Starters. Speed-torque characteristics of DC motors. Speed control .Losses and efficiency.		
UNIT II	**TRANSFORMERS**	**9**
Theory and operation, Phasor diagram, equivalent circuit, open and short circuit tests. Performance estimation, Auto-transformers. Parallel operation, three phase transformer Connections. Instrument transformers: CT&PT		
UNIT III	**SYNCHRONOUS MACHINES**	**9**
Alternators - types and constructional features - emf equation, Concept of synchronous reactance, regulation by EMF and MMF methods, Synchronous motor starting and V curves.		
UNIT IV	**INDUCTION MACHINES**	**9**
Poly phase Induction motors - types and constructional features - equivalent circuit - starting and speed control, circle diagram, induction generators.		
UNIT V	**SINGLE PHASE INDUCTION MACHINES**	**9**
Single phase induction motors -types and constructional features-principle of operation equivalent circuit based on double revolving field theory, Shaded pole induction motor-Linear reluctance motor-Hysteresis motor-AC series motor.		
		TOTAL: 45 PERIODS

TEXT BOOKS:

3. Dr. P.S. Bhimbra, 'Electrical Machinery', Khanna Publications, 7th Edition, 2007.
4. Nagrath, I.J.and Kothari, D.P., 'Electrical Machines', Tata McGraw Hill Education Private Limited Publishing Company Ltd., 4th Edition, 2010.

REFERENCE BOOKS:

5. M. G. Say, 'Performance and design of Alternating Current Machines', John Wiley and Sons Publications, 3rd Edition, 1983.
6. Arthur Eugene Fitzgerald and Charles Kingsley, 'Electric Machinery', Tata McGraw Hill Education Publications, 6th Edition, 2002.
7. Miller, T.J.E., 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press-Oxford, 1989.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE122	**INDUSTRIAL ELECTRICAL SYSTEMS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Open Elective

PREAMBLE: This course helps to understand about overview of electric systems in manufacturing

PREREQUISITE COURSES: Basic Electrical Engineering

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to make the students,

- 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	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Basics about electrical equipment are in manufacturing.	K2
CO2	Application of electrical equipment's in different types of industries.	K2
CO3	Types and working of electric traction systems.	K2
CO4	Industry oriented consumption of electrical energy.	K2
CO5	Basics about Illumination and its types.	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
CO2	**H**							**H**		**M**	**H**		L	M
CO3	**H**			**H**				**H**		**M**	**H**		L	M
CO4		**M**	**M**	**L**		**M**		**M**		**M**				
CO5										**H**				

COURSE CONTENT :		
UNIT I	**ELECTRIC DRIVES AND CONTROL**	**9**
Group drive – Individual drive – selection of motors – starting and running characteristics– Mechanical features of electric motors – Drives for different industrial applications - Choice of drives – power requirement calculation.		
UNIT II	**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.		
UNIT III	**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 Levitation		
UNIT IV	**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 V	**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.		
TOTAL: 45 PERIODS		

TEXTBOOKS:

1. Open Shaw Taylor, 'Utilization of Electrical Energy', Oriented Longmans Limited (Revised in SI Units), 1971.
2. Uppal S.L, 'Electric Power', Khanna Publishers, 1988.

REFERENCE BOOKS:

1. Soni A. Chakrabarti, M.L.Soni, P.V.Gupta, U.S.Bhatnagar, 'A text book on Power System Enggineering', Khanna Publishers, 2000.
2. A.I.Starr, 'Generation, Transmission and Utilization of Electric Power', ELBS, 1978.
3. C. L Wadhwa , 'Generation ,Distribution and Utilization of Electrical Energy'.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE123	**COMPUTER AIDED ANALYSIS OF ELECTRICAL APPARATUS**	**2**	**0**	**2**	**3**

COURSE CATEGORY: Open Elective

PREAMBLE: This course will provide in depth knowledge on DC & AC machines concepts by theoretically reading and practically simulating.

PREREQUISITE COURSES: Basic Electrical Engineering.

COURSE EDUCATIONAL OBJECTIVES:

To impart knowledge on

- To provide knowledge on purpose and procedure of Finite Element Analysis method.
- To educate the design, mesh creation and types of solvers in MagNet software by practical simulation.
- To provide knowledge on DC machine construction, working principle and DC series motor design using MagNet simulation software.
- To educate the operation of transformer by theoretical, design of core and shell type transformer using MagNet simulation software.
- To educate the concept of three phase Induction machines and design of squirrel cage induction motor using MagNet simulation software.

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 purpose of FEA and types of Finite Elements	K2
CO2	Show the model of object, elements in 1D,2D,3D and types of solvers using MagNet software	K3
CO3	Explain the concept, types of DC machine and show the simulation of DC series motor using MagNet software	K3
CO4	Explain the principle, types of transformer and show the simulation of core, shell type transformer using MagNet software	K3
CO5	Explain the principle, types of DC machine and show the simulation of Squirrel cage induction motor using MagNet software	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	M					
CO2	M		H	L				H	M					
CO3	M		M	H	L			H	M		M			
CO4	M		M	H	L			H	M		M			
CO5	M		M	H	L			H	M		M			

COURSE CONTENT:		
UNIT I	**INTRODUCTION TO FEA**	**9**
History- Purpose of FEA- Discretization model-Mesh refinement- Types of Finite elements- Boundary condition- general procedure for FEA (Preprocessing, solution, post processing)- Application of FEA.		
UNIT II	**BASICS OF MAGNET SOFTWARE**	**9**
Introduction-Design of Object-Elements-Nodes- make component in a line- one dimension design of line,- two dimension design of Cylinder, rectangular, cube –three dimension design of fan, wheel, spanner- - initial 2D mesh-Types of solvers.		
UNIT III	**DC MACHINE**	**9**
Principle-EMF equation- speed torque equation- Electrical/Mechanical characteristics- starters- applications - design of series DC motor: Wireframe model-solid model-Transient 2D with motion analysis.		
UNIT IV	**TRANSFORMER**	**9**
Principle and operation-EMF equation-Phasor diagram, equivalent circuit-Application-design of core and shell type transformer: Wireframe model-solid model-static analysis.		
UNIT V	**THREE PHASE INDUCTION MOTOR**	**9**
Three phase Induction Motor types and constructional features–Torque equation-star delta and DOL starter- applications, design of Squirrel cage Motor: Wireframe model-solid model- Transient 2D with motion analysis.		
		TOTAL: 45 PERIODS

TEXTBOOKS:

1. Reddy.J.N., 'An Introduction to the Finite Element Method', 3rd Edition, Tata McGraw-Hill, 2005
2. Seshu,P, 'Test book of Finite Element Analysis', Prentice-Hall of India Pvt.Ltd., New Delhi, 2007

REFERENCE BOOKS:

1. Dr. P.S. Bhimbra, 'Electrical Machinery', Khanna Publications, 7th Edition, 2007.
2. Nagrath, I.J.and Kothari, D.P., 'Electrical Machines', Tata McGraw Hill Education Private Limited Publishing Company Ltd., 4th Edition, 2010.
3. M. G. Say, 'Performance and design of Alternating Current Machines', John Wiley and Sons Publications, 3rd Edition, 1983.
4. Rao,S.S., 'The Finite Element Method in Engineering', 3rd edition, Butterworth Heinemann, 2004.

COURSE CODE: **10213EE124**	COURSE TITLE: **GREEN ENERGY RESOURCES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE CATEGORY: Open Elective

PREAMBLE: This course focuses on the renewable energy based electric energy generation: Solar, Wind, Bio Energy, Waste to energy, other renewable energy resources.

PREREQUISITE COURSES: Basic Electrical Engineering.

COURSE EDUCATIONAL OBJECTIVES :

To impart knowledge on

- Concepts of the renewable energy sources like wind, solar, Bio and other renewable energy resources.
- Environmental friendly energy production and consumption.
- 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 its importance.	K2
CO2	Understand the process of photovoltaic power generation.	K2
CO3	Explain the process of power generation using wind energy resources.	K2
CO4	Summarize the power generation using Bio energy techniques.	K2
CO5	Summarize the fundamentals and the other renewable energy resource 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											L	L	L	L
CO2		H	H					M	M					
CO3		H												
CO4			H		H	L	H				L	L		
CO5		L			L			M	M		L	L	M	M

COURSE CONTENT

UNIT I	**INTRODUCTION**	**6**

Energy needs of India, classification of energy sources, energy efficiency and energy security, importance of renewable energy resources.

UNIT II	SOLAR ENERGY	12
Basic concepts, types of collectors, collection systems, photo voltaic (PV) technology: solar thermal effect, solar cells, characteristics of PV systems, equivalent circuit, and array design, building integrated PV system and efficiency calculations, applications.		
UNIT III	**WIND ENERGY**	**9**
Wind power systems, wind speed and power relation components, turbine types, turbine rating. Choice of generators and site selection, wind energy forecasting, variable speed operation, maximum power operation,		
UNIT IV	**BIO ENERGY**	**9**
Bio-mass and bio-gas**:** principles of bio-conversion, bio-gas digesters types, gas yield, and combustion characteristics, fermentation and wet processes, applications-utilization for cooking		
UNIT V	**OTHER RENEWABLE ENERGY RESOURCES**	**9**
Geothermal energy, ocean thermal energy, wave energy, Tidal energy, waste to energy, heat to energy, Fuel cells: types and applications.		
		TOTAL: 45 PERIODS

TEXTBOOKS:

1. Rai G.D, 'Non-conventional Energy Sources' Khanna Publishers, 2006.
2. A.Duffie and W.A.Beckmann, 'Solar Engineering of Thermal Processes', John Wiley, 1980.

REFERENCE BOOKS:

1. F.Kreith and J.F.Kreider, 'Principles of Solar Engineering', McGraw-Hill (1978).
2. T.N.Veziroglu, 'Alternative Energy Sources', Vol 5 and 6, McGraw-Hill (1978).
3. David Hu. 'Hand Book of Industrial Energy Conservation', Van Nostrand Co., 1983.

ONLINE RESOURCES:

1. books.google.co.in
2. www.scribd.com/.../Solar-engineering-of-Thermal-processes-Duffie

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE125	**ROBOTICS AND AUTOMATION**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Open Elective

PREAMBLE: To enable students to understand about the working concepts of robot and its role in automation.

PREREQUISITE COURSES: Basic Electrical Engineering

COURSE EDUCATIONAL OBJECTIVES :

- To study the basics of robots.
- To discuss about the different actuators of Robot.
- To understand the kinematics and inverse kinematics of robots.
- To analyse the trajectory planning for robot.
- To elaborate the control of robots for some specific 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	Understand the basics of robots	K2
CO2	Elaborate the function of different sensors in the robot	K2
CO3	Understand the concepts of gripper and robot control	K2
CO4	Write program to use robot for a typical application	K2
CO5	Manipulate robots in different 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**													
CO2	**H**							**H**		**M**	**H**			
CO3	**H**			**H**				**H**		**M**	**H**			
CO4		**M**	**M**	**L**		**M**		**M**		**M**			M	M
CO5										**H**			M	M

COURSE CONTENT :		
UNIT I	**BASIC CONCEPTS**	**9**
Definition and origin of robotics – different types of robot – various generations of robots – degrees of freedom – Asimov's laws of robotics – dynamic stabilization of robots.		
UNIT II	**POWER SOURCES AND SENSORS**	**9**
Hydraulic - pneumatic - electric drives – variable speed arrangements – path determination – micro machines in robotics – artificial intelligent– machine vision – ranging – laser – acoustic – magnetic, fibre optic and tactile sensors.		
UNIT III	**MANIPULATORS, ACTUATORS AND GRIPPERS**	**9**
Construction of manipulators – manipulator dynamics and force control – electronic and pneumatic manipulator control circuits – end effectors – grippers – design considerations.		
UNIT IV	**KINEMATICS AND PATH PLANNING**	**9**
Kinematic problems - Solution of inverse kinematics problem – hill climbing techniques – robot programming languages- sliding mode control		
UNIT V	**APPLICATIONS**	**9**
Multiple robots – robot cell design – selection of robot – Micro and Nano robots– machine interface – robots in manufacturing and non- manufacturing applications.		
		TOTAL: 45 PERIODS

TEXTBOOKS:

1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., 'Industrial Robotics', Mc Graw-Hill Singapore, 1996.
2. Ghosh, 'Control in Robotics and Automation: Sensor Based Integration', Allied Publishers, Chennai, 1998.

REFERENCE BOOKS:

1. Klafter R.D., Chimielewski T.A., Negin M., 'Robotic Engineering – An integrated Approach', Prentice Hall of India, New Delhi, 1994.
2. Mc Kerrow P.J. 'Introduction to Robotics', Addison Wesley, USA, 1991.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE126	**WIND ENERGY TECHNOLOGY**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Open 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

COURSE EDUCATIONAL OBJECTIVES :

- To learn about Power extraction from wind energy.
- To distinguish the components and design of wind tower.
- To 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	Express the relation between speed and power	K2
CO2	Classify the components of wind tower	K2
CO3	Demonstrate the design features of wind tower	K2
CO4	Explain the principle of operation of Types of generator	K2
CO5	Understand operation and control of wind power	K2

CORRELATION OF COs WITH POs AND PSOs

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

COURSE CONTENT :

UNIT I	INTRODUCTION	9

Speed and Power Relations, Power Extracted from the Wind, Rotor Swept Area, Air Density, Global Wind Patterns, Wind Speed Forecasting, Wind Resource in India.

UNIT II	WIND TURBINE COMPONENTS	9
System Components: Tower, Turbine Blades, Yaw Control, Pitch Control, Gearbox, Safety brakes, Generator, Transformer, Anemometer.		
UNIT III	**TOWER DESIGN**	**9**
System Design Features: Number of Blades, Rotor Upwind, Downwind, Horizontal axis wind turbines, Vertical axis wind turbines, Spacing of the Towers.		
UNIT IV	**TYPES OF GENERATORS**	**9**
Types of Generator: Induction generator, Synchronous generator, Fixed and variable speed operations, Grid integration.		
UNIT V	**CONTROL OF WIND POWER**	**9**
Maximum Power Operation: Constant Tip-Speed Ratio Scheme, Peak Power Tracking Scheme; System Control Requirements: Speed and Rate Control.		
		TOTAL: 45 PERIODS

TEXTBOOKS:

1. Mukund R. Patel 'Wind and Solar Power Systems: Design, Analysis, and Operation' -CRC Press (1999).
2. Sathyajith Mathew, 'Wind Energy Fundamentals, Resource Analysis and Economics' Springer (2006).

REFERENCE BOOKS:

1. S.N.Bhadra, D.Kastha,S.Banerjee, 'Wind Electrical Systems', Oxford University Press, 2010.
2. Ion Boldea, 'Variable Speed Generators', Taylor & Francis Group, 2006.
3. E.W. Golding "The Generation of Electricity by Wind Power", Redwood Burn Ltd., Trowbridge, 1976.
4. N. Jenkins, 'Wind Energy Technology' John Wiley & Sons, 1997.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE127	**ELECTRICAL SAFETY AND SAFETY MANAGEMENT**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Open Elective

PREAMBLE: This course will enable the students to understand the basic concepts of electrical safety and regulations

PREREQUISITE COURSES: Basic Electrical Engineering

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	Understand the Indian electricity rules and their significance.	K2
CO2	Explain the safety standard in residential, commercial, and agricultural.	K2
CO3	Learn about electrical safety installation, testing.	K2
CO4	Understand about flashovers and corona discharge.	K2
CO5	Understand about electrical safety in distribution 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		H					M	M					
CO2	M		H	L				H	M					
CO3	M		M	H	L			H	M		M			
CO4	M		M	H	L			H	M		M			
CO5	M		M	H	L			H	M		M		L	L

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, equipment's 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 – equipment's – 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: **10213EE201**	COURSE TITLE: **SWITCH MODE POWER SUPPLY DESIGN AND DEVELOPMENT**	L	T	P	C
		2	**0**	**2**	**3**

COURSE CATEGORY: Open 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 to designing an SMPS for the given equipments.

PREREQUISITE COURSES: Basic Electrical Engineering, Basic Electronics Engineering

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- To understand detailed insight of SMPS and its various topologies
- To design and fabricate 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	Deliver the fundamental concept of SMPS	K2
CO2	Understand the working of rectifier, chopper, amplifier circuit, voltage and current sensors.	K2
CO3	Explain the various SMPS topologies	K2
CO4	Design SMPS for specific applications	K6
CO5	Analyze 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	L		H								M			
CO2	M							L			L			
CO3			M								M			
CO4			H					M			M			
CO5			M										L	L

COURSE CONTENT:		
UNIT I	**INTRODUCTION**	**6**
Introduction to SMPS-types-evolution- need of SMPS- Linear Regulator vs SMPS – Block diagram-advantages-Applications		
UNIT II	**COMPONENTS**	**6**
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**	**6**
Buck, Boost, Buck-Boost, Push-Pull, Fly back, Resonant, forward Converter- Operation.		
UNIT IV	**DESIGN OF SMPS**	**6**
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**	**6**
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: 30 PERIODS

TEXT BOOKS:

1. Keith Billings, Taylor Morey, 'Switch mode Power Supply Handbook', 3rd Edition, McGraw-Hill Education, New York, 2012.
2. Maniktala, Sanjaya (2006), Switching Power Supplies A to Z, Newnes /Elsevier, ISBN 0-7506-7970-0

REFERENCE BOOKS:

1. Abraham I. Pressman, Keith Billingss, Taylor Morey 'Switching Power Supply Design', 3rd Edition, New York: McGraw-Hill, 1999
2. ON Semiconductor (July 11, 2002). 'SWITCHMODE Power Supplies—Reference Manual and Design Guide' (PDF). Retrieved 2011.

EXPERIMENTS: (15 PERIODS)

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:	COURSE TITLE:	L	T	P	C
10213EE301	**VOLTAGE STABILIZER FABRICATION**	**0**	**0**	**2**	**1**

COURSE CATEGORY: Open 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

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- Identify the requirement of voltage stabilizer for domestic equipments.
- To design of transformer for a given power rating of voltage stabilizer.
- To understand design procedures of relay driver circuit for voltage stabilizer.
- To familiarize with the 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	Understand the basics of voltage stabilizer	K2
CO2	Design of transformer for voltage stabilizer	K6
CO3	Design of relay driver circuit	K6
CO4	Select the voltage stabilizer for specific application	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	L	M	M		L				H		H		
CO2	L	M	L	H		M				H		H	L	L
CO3	M	M	H	H		H				L		H	L	L
CO4	L	M	L	H		L				H		H	M	M

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

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 PERIODS

TEXTBOOKS:

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

REFERENCE BOOKS:

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.

B.Tech. Programme Specialization in Computer Systems

List of Courses (18 Credits)

S.NO.	COURSE CODE	COURSE NAME	L	T	P	C
1.	10212EE101	Computer Architecture	3	0	0	3
2.	10212EE102	Operating Systems	3	0	0	3
3.	10212EE103	Object Oriented Programming	3	0	0	3
4.	10212EE104	Data Structures and Algorithms	3	0	0	3
5.	10212EE105	Computer Networks and Communication	3	0	0	3
6.	10212EE106	Artificial Intelligence	3	0	0	3

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE101	**COMPUTER ARCHITECTURE**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Specialization

PREAMBLE: In this course, students study the basic structure of arithmetic and logical unit, memory unit, control unit and I/O unit of a digital computer and its function.

PREREQUISITE COURSES: NIL

COURSE EDUCATIONAL OBJECTIVES :

- To understand the basic structure and operation of digital computer
- To study the design of arithmetic and logic unit and implementation of fixed point and floating-point operations
- To study the different ways of communicating with I/O devices and standard I/O interfaces
- To study the types of control unit techniques and the concept of pipelining

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 structure and functional operation of a digital computer.	K2
CO2	Familiarize with arithmetic algorithms and procedure for implementing them in hardware.	K2
CO3	Elaborate the pipeline for consistent execution of instructions with minimum hazards in data processing units	K2
CO4	Summarize the different types of I/O devices and standard interfaces in communication	K2
CO5	Identify performance consideration in Memory Management and design of a digital computer.	K3

CORRELATION OF COs AND POs

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

COURSE CONTENT :		
UNIT I	**BASIC STRUCTURE OF COMPUTERS**	**9**
Functional units – Basic operational concepts - Bus structures – Software performance – Memory locations and addresses – Memory operations – Instruction and instruction sequencing – Addressing modes – Assembly language – Basic I/O operations .		
UNIT II	**ARITHMETIC UNIT**	**9**
Addition and subtraction of signed numbers – Design of fast adders –Multiplication of positive numbers – Signed operand multiplication and fast multiplication – Integer division – Floating point numbers and operations.		
UNIT III	**BASIC PROCESSING UNIT**	**9**
Fundamental concepts – Execution of a complete instruction – Multiple bus organization – Hardwired control – Micro programmed control – Pipelining –Basic concepts – Data hazards – Instruction hazards – Influence on Instruction sets – Data path and control consideration.		
UNIT IV	**I/O ORGANIZATION**	**9**
I/O device Access – Interrupts – DMA – Buses – Interface circuits – Standard I/O Interfaces		
UNIT V	**MEMORY SYSTEM**	**9**
Basic concepts – Semiconductor RAM – ROM –Flash Memory – RAID operations - Speed of operation – size and cost – Cache memories – Performance consideration – Memory Management requirements – Secondary storage- Virtual memory		
TOTAL: 45 PERIODS		

TEXTBOOKS:

1. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, 'Computer Organization', McGraw-Hill, Fifth Edition, Reprint 2012.
2. David A. Patterson and John L. Hennessy, 'Computer Organization and Design: The Hardware/Software Interface', Fourth Edition, Elsevier, 2011

REFERENCE BOOKS:

1. Ghosh T. K., 'Computer Organization and Architecture', Tata McGraw-Hill, 3rd Edition, 2011.
2. M.Morris Mano, 'Computer System Architecture', 3rd Edition, Pearson Education, 2007.
3. BehroozParhami, 'Computer Architecture', Oxford University Press, 2007.
4. John P. Hayes, 'Computer Architecture and Organization', 3rd Edition, Tata McGraw Hill, 1998.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE102	**OPERATING SYSTEMS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Specialization

PREAMBLE: To provide an introduction to the operating system functions, design and implementation of how an operating system controls the computing resources and provide services to the users.

PREREQUISITE COURSES: NIL

COURSE EDUCATIONAL OBJECTIVES :

- To understand the structure and functions of OS
- To learn about Processes, Threads and Scheduling algorithms
- To understand the principles of concurrency and Deadlocks
- To learn various memory management schemes
- To study I/O management and File 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 basic elements and overview of operating system program and its functions	K2
CO2	Apply the concept of process management to real time problems	K3
CO3	Illustrate the concepts of concurrency and scheduling algorithms	K2
CO4	Elaborate the concepts of various memory management techniques and its implementation	K2
CO5	Summarize the File management and Input/output device management	K2

CORRELATION OF COs WITH POs and PSOs

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

COURSE CONTENT :		
UNIT I	**INTRODUCTION**	**9**
Computer System Overview-Basic Elements, Instruction Execution, Interrupts, Memory Hierarchy, Multiprocessor and Multicore Organization. Operating system overview-objectives and functions, Evolution of Operating System.		
UNIT II	**CPU SCHEDULE AND PROCESS**	**9**
Process concepts and scheduling, Operations on processes, Processes and Threads, Types of Threads, Multicore and Multithreading, Windows OS - Thread and Symmetric Multi-Processing - Introduction to RTOS and its applications - Linux operating system		
UNIT III	**CONCURRENCY AND SCHEDULING**	**9**
Principles of Concurrency - Mutual Exclusion, Semaphores, Monitors, Readers/Writers problem. Deadlocks – prevention- avoidance – detection, Scheduling- Types of Scheduling – Scheduling algorithms		
UNIT IV	**MEMORY MANAGEMENT**	**9**
Memory management requirements, Partitioning, Paging and Segmentation, Virtual memory - Hardware and control structures, Segmentation with Paging, Linux memory management, Windows memory management.		
UNIT V	**FILE SYSTEM INTERFACE AND OPERATION**	**9**
File management – Organization, Directories, File sharing, and Record blocking, secondary storage management, I/O management and disk scheduling – I/O devices, I/O functions, OS design issues, disk scheduling and Disk cache.		
TOTAL: 45 PERIODS		

TEXTBOOKS:

1. William Stallings, 'Operating Systems – internals and design principles', Prentice Hall, 7th Edition, 2011.
2. Silberschatz, Peter Galvin, Greg Gagne 'Operating System Principles', Wiley India, 7th Edition, 2006.

REFERENCE BOOKS:

1. Andrew S. Tannenbaum & Albert S. Woodhull, 'Operating System Design and Implementation', Prentice Hall, 3rd Edition, 2006.
2. Andrew S. Tannenbaum, 'Modern Operating Systems', Prentice Hall, 3rd Edition, 2007.
3. Gary J.Nutt, 'Operating Systems', Pearson/Addison Wesley, 3rd Edition 2004.
4. Pramod Chandra P.Bhatt, 'An Introduction to Operating Systems Concepts and Practice', Prentice Hall India, 3rd Edition, 2010.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE103	**OBJECT ORIENTED PROGRAMMING**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Specialization

PREAMBLE: To understand and development C++ Programming language and mastering in OOPS for real time applications

PREREQUISITE COURSES: NIL

COURSE EDUCATIONAL OBJECTIVES :

- To understand Object Oriented Programming concepts and basic characteristics of Java
- To know the principles of packages, inheritance and interfaces
- To define exceptions and use I/O streams
- To develop a java application with threads and generics classes
- To design and build simple Graphical User Interfaces

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 object-oriented programming concepts and its features	K2
CO2	Apply the concepts of inheritance and interface for implementation in real time applications	K3
CO3	Implementation of programming in C++ and its functions	K3
CO4	Summarize the use of virtual functions to implement multi-thread and Generic Programming	K2
CO5	Illustrate the features of event driven programming.	K2

CORRELATION OF COs WITH POs AND PSOs

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

COURSE CONTENT :

UNIT I	INTRODUCTION TO OOPS	9

Fundamentals of OOPS – Features of Object Oriented Programming – objects and classes - Encapsulation- Inheritance - Polymorphism- Control flow – Arrays – Strings – Pointers and Functions

UNIT II	INHERITANCE AND INTERFACES	9
Inheritance – Super classes- sub classes –Protected members – constructors in sub classes- the Object class – abstract classes and methods- final methods and classes – Interfaces – defining an interface, implementing interface, differences between classes and interfaces and extending interfaces - Object cloning		
UNIT III	**PROGRAMMING IN C++**	**9**
Constructors and Destructors – Operator Overloading –Virtual Functions and Exception Handling - exception hierarchy - Input / Output Basics - Reading and Writing Console		
UNIT IV	**MULTITHREADING AND GENERIC PROGRAMMING**	**9**
Differences between multi-threading and multitasking, thread life cycle, creating threads, synchronizing threads, Inter-thread communication, daemon threads, thread groups. Generic Programming – Generic classes – generic methods – Bounded Types – Restrictions and Limitations.		
UNIT V	**EVENT DRIVEN PROGRAMMING**	**9**
Graphics programming - Frame – Components - working with 2D shapes - Using colour, fonts, and images - Basics of event handling - event handlers - adapter classes - actions - mouse events - AWT event hierarchy - Introduction to Swing – layout management - Swing Components – Text Fields , Text Areas – Buttons- Check Boxes – Radio Buttons – Lists- choices- Scrollbars – Windows –Menus – Dialog Boxes.		
		TOTAL: 45 PERIODS

TEXTBOOKS:

1. Herbert Schildt, 'Java the Complete Reference', 8th Edition, McGraw Hill Education, 2011.
2. Cay S. Horstmann, Gary Cornell, 'Core Java Volume – I Fundamentals', 9th Edition, Prentice Hall, 2013.

REFERENCE BOOKS:

1. Paul Deitel, Harvey Deitel, 'Java SE 8 for programmers', 3rd Edition, Pearson, 2015.
2. Timothy Budd, 'Understanding Object-Oriented Programming with Java', Updated Edition, Pearson Education, 2000.

COURSE CODE: **10212EE104**	COURSE TITLE: **DATA STRUCTURES AND ALGORITHMS**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Specialization

PREAMBLE: This course will impart knowledge in various data structures and analysis of algorithm concepts for different applications.

PREREQUISITE COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES :

- To study various data structure concepts like Stacks, Queues, Linked List, Trees and Files
- To overview the applications of data structures
- To be familiar with utilization of data structure techniques in problem solving
- To have a comprehensive knowledge of data structures and algorithm
- To carry out asymptotic analysis of algorithm

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 user defined data types, linear data structures for solving real world problems.	K2
CO2	Implement modular programs on nonlinear data structures and algorithms for solving engineering problems efficiently	K3
CO3	Illustrate special trees and Hashing Techniques	K2
CO4	Apply searching techniques in graph traversal	K3
CO5	Apply sorting techniques for real world problems	K3

CORRELATION OF COs WITH POs AND PSOs

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

COURSE CONTENT :		
UNIT I	**INTRODUCTION**	**9**
Introduction – The Problem Solving – Top down design Strategy – Algorithms Vs Programs– Implementations of algorithms – Program Verification – The efficiency of algorithms – Algorithmic Notation – Asymptotic Notation – Mathematical Induction – Analysis of Algorithms – Recurrence Relations.		
UNIT II	**LINEAR DATA STRUCTURES**	**9**
Lists – Arrays – Linked Representation – Singly Linked List – Doubly linked List – Cursor Based Linked list – Applications of lists – Stacks – Stack ADT – Array Implementation – Applications – Linked List Design – Queue ADT – Implementation – Applications.		
UNIT III	**TREES**	**9**
Basic Tree Concepts – Binary Trees – Implementation –Tree Traversals – Applications – Binary Search Trees – AVL trees.		
UNIT IV	**GRAPHS**	**9**
Basic Concepts – Traversal – Minimum Spanning Tree – Applications – Networks – Single Source Shortest Path Algorithm –Topological Sort.		
UNIT V	**BACK TRACKING**	**9**
The General Method – 8 Queens Problem – Sum of Subsets – Graph Coloring – Hamiltonian Cycle – Knapsack Problem – Branch and Bound Method – Travelling Salesman problem – P and NP Completeness		
		TOTAL: 45 PERIODS

TEXTBOOKS:

1. Mark Allen Weiss, 'Data Structures and Algorithm Analysis in C', 2nd Edition, Pearson Education, 2007.
2. Reema Thareja, 'Data Structures Using C', Oxford Higher Education , 1st Edition, 2011

REFERENCE BOOKS:

1. Sartaj Sahni, 'Data Structures, Algorithms and Applications in C++', McGraw Hill, 2nd Edition, 2005.
2. Sanjay Pahuja, 'A Practical Approach to Data Structures and Algorithms', New Age International, 1st Edition, 2010.

COURSE CODE: 10212EE105	COURSE TITLE: COMPUTER NETWORKS AND COMMUNICATION	L	T	P	C
		3	0	0	3

COURSE CATEGORY: Specialization

PREAMBLE: This course introduces the concepts and fundamentals of computer networks, data communication and techniques in layered network architecture and their protocols.

PREREQUISITE COURSES: Data Structures

COURSE EDUCATIONAL OBJECTIVES :

- Build an understanding of the fundamental concepts of computer networking, protocols, architectures, and applications
- Gain expertise in design, implement and analyze performance perspective of ISO OSI layered Architecture
- Deal with the major issues of the layers of the model.

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 architecture and building blocks of Communication network	K2
CO2	Explain the types of network topology and performance analyse of network	K2
CO3	Summarize the error detection and correction mechanisms, flow control mechanisms of various routing protocols	K2
CO4	Compare the performance of network layer and transmission layer protocol	K3
CO5	Elaborate the functionality of various layer and its associated protocols	K2

CORRELATION OF Cos WITH POs AND PSOs

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

COURSE CONTENT :

UNIT I	INTRODUCTION	9

Computer networks and distributed systems Classifications, network structures, Data communication, Data representation and Data flow, Connection Topology, Protocols and Standards, OSI model, Transmission Media

UNIT II	NETWORK TOPOLOGY TYPES	9
Wired LAN, Wireless LAN, Virtual LAN-Techniques for Bandwidth utilization- Multiplexing - Frequency division, Time division and Wave division, Concepts on spread spectrum.		
UNIT III	**DATA LINK LAYER**	**9**
Fundamentals of Error Detection and Correction, Block coding, Hamming Distance, CRC-Flow Control and Error control protocols - Stop and Wait, Go-back–N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, Random Access, Multiple access protocols - Pure ALOHA, Slotted ALOHA, CSMA/CD, CDMA/CA		
UNIT IV	**NETWORK & TRANSPORT LAYER**	**9**
Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP, RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routing protocols. Process to Process Communication, User Datagram Protocol, Transmission Control Protocol , SCTP Congestion Control; Quality of Service , QoS improving techniques - Leaky Bucket and Token Bucket algorithms.		
UNIT V	**APPLICATION LAYER**	**9**
DNS, DDNS, TELNET, EMAIL, FTP, WWW, HTTP, SNMP, Bluetooth, Firewalls.		
		TOTAL: 45 PERIODS

TEXTBOOKS:

1. Tanenbaum, 'Computer Networks', Pearson Education, 5th Edition, 2013.
2. William Stallings 'Data and Computer Communications' Pearson Education India, 2013.

REFERENCE BOOKS:

1. Perlman, R., Kaufman, C., and Speciner, M. 'Network Security: Private Communication in a Public World' Pearson Education India, 2016.
2. Stevens, W. R., Fenner, B., and Rudoff, A. M. 'UNIX Network Programming' Volume 1, SMIT-SMU, 2018.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE106	**ARTIFICIAL INTELLIGENCE**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Specialization

PREAMBLE : This course will make the students to understand, analyse and design an Artificial Intelligence of most advanced fields which involves use of Mathematics, Statistics, Information Technology and Information Sciences in discovering new information and knowledge from large databases and optimize Human effort overall.

PREREQUISITE COURSES: Data Structures and algorithm

COURSE EDUCATIONAL OBJECTIVES :

- To understand the various characteristics of Intelligent agents
- To learn the different search strategies in AI
- To learn to represent knowledge in solving AI problems
- To understand the different ways of designing software agents
- To know about the various applications of AI.

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 appropriate search algorithms of AI for real world application	K2
CO2	Explain the various problem solving methods using first order and predicate logic	K2
CO3	Develop the radiate Logic and knowledge representation of solve a given problem	K3
CO4	Develop the software agents for solving a given problem	K3
CO5	Choose applications for NLP that use Artificial Intelligence.	K3

CORRELATION OF COs WITH POs AND PSOs

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

COURSE CONTENT :		
UNIT I	**INTRODUCTION**	**9**
Introduction to AI - Problem-Solving Agents - Searching for Solutions- Characteristics of Intelligent Agents–Typical Intelligent Agents – Problem Solving Approach to Typical AI problems.		
UNIT II	**PROBLEM SOLVING METHODS**	**9**
Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics - Local Search Algorithms and Optimization Problems - Searching with Partial Observations - Constraint Satisfaction Problems – Constraint Propagation - Backtracking Search - Game Playing - Optimal Decisions in Games – Alpha - Beta Pruning - Stochastic Games		
UNIT III	**KNOWLEDGE REPRESENTATION**	**9**
First Order Predicate Logic – Prolog Programming – Unification – Forward Chaining-Backward Chaining – Resolution – Knowledge Representation - Ontological Engineering-Categories and Objects – Events - Mental Events and Mental Objects - Reasoning Systems for Categories - Reasoning with Default Information		
UNIT IV	**SOFTWARE AGENTS**	**9**
Architecture for Intelligent Agents – Agent communication – Negotiation and Bargaining – Argumentation among Agents – Trust and Reputation in Multi-agent systems.		
UNIT V	**APPLICATIONS**	**9**
AI applications – Language Models – Information Retrieval- Information Extraction – Natural Language Processing - Machine Translation – Speech Recognition – Robot – Hardware – Perception – Planning – Moving		
		TOTAL: 45 PERIODS

TEXTBOOKS:

1. S. Russell and P. Norvig, 'Artificial Intelligence: A Modern Approach' Prentice Hall, 3rd Edition, 2009.
2. I.Bratko 'Prolog: Programming for Artificial Intelligence', 4th Edition, Addison-Wesley Educational Publishers Inc., 2011.

REFERENCE BOOKS:

1. M. Tim Jones, 'Artificial Intelligence: A Systems Approach (Computer Science)', Jones and Bartlett Publishers, Inc.; 1st Edition, 2008
2. Nils J. Nilsson, 'The Quest for Artificial Intelligence', Cambridge University Press, 2009.
3. William F. Clocksin and Christopher S. Mellish, 'Programming in Prolog: Using the ISO Standard', 5th Edition, Springer, 2003.
4. Gerhard Weiss, 'Multi Agent Systems', 2nd Edition, MIT Press, 2013.

Minor Degree in Electric Vehicle Technology

List of Courses (18 Credits)

Sl.No	Course Code	Lecture Courses	L	T	P	C
1	10213EE131	Charging Station	3	0	0	3
2	10213EE132	Battery Management System	3	0	0	3
3	10213EE133	Electric Propulsion System and Control	3	0	0	3
4	10213EE134	Hybrid Electric Vehicle Technologies	3	0	0	3
5	10213EE135	Energy Storage Systems and Control	3	0	0	3
6	10213EE136	Modelling and Simulation of EV	2	0	2	3

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE131	**CHARGING STATION**	**3**	**0**	**0**	**3**

COURSE CATEGORY: MINOR

PREAMBLE: This course focuses on the development of electric vehicle charging stations based on conventional and renewable energy applications and issues associated with integration.

PREREQUISITE COURSES: Basic Electrical & Electronics Engineering

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Introduce about charging stations for electric vehicles.
- Impart knowledge about charging methodologies and grid integration issues.
- Explain about conventional and renewable energy based charging methods.

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	Outline about EV charging stations, site selection issues and economic analysis.	K2
CO2	Explain about equipment selection guidelines needed to design charging stations.	K2
CO3	Summarize the methods of charging of electric vehicle batteries and hybrid energy storage devices.	K2
CO4	Discuss about the standards and integration issues of charging stations.	K2
CO5	Explain about renewable energy based charging stations.	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				L	M	M	
CO2	H	M	L			L	M				L	M	M	
CO3	H	M					M				L	M	M	
CO4	H	M	L			L	M	L			L	M	M	
CO5	H	M					M				L	M	M	

COURSE CONTENT:

UNIT I	INTRODUCTION	9

Charging station overview – equipment specifications - typical site plans – characteristics of EV supply equipment - location selection – siting issues – Methods of reducing installation cost – public and private charging stations.

UNIT II	EQUIPMENT SELECTION	9
Types of chargers - Selection of AC & DC charger - AC & DC pile charger –selection and sizing of distribution transformer – distribution board – HT equipment – HT and LT cables – relay selection – slow charging and fast charging design – difference between slow and fast charger.		
UNIT III	**EV CHARGING STRATEGIES**	**9**
Traditional charging methods: trickle, pulse charging - improvement of CCCV charging - Wireless power Transfer- Far field Strategies: micro wave, laser radiation - Near field strategies: inductive, capacitive, hybrid charging – fast charging - fleet management		
UNIT IV	**CHARGING STATION INTEGRATION**	**9**
Types of EV charging stations – EV charging standards – Levels of charging – Vehicle to Grid (V2G), Vehicle to Home (V2H) technologies and its challenges – Impact of EV on grid – congestion in power lines – Vehicle to Vehicle (V2V) charging – Battery swapping.		
UNIT V	**RENEWABLE ENERGY CHARGING**	**9**
Solar charging for electric vehicles – wind charging stations - power rating selection – charging issues due to battery chemistry and rating – future trends.		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Rai G D, 'Non-Conventional Sources Of Energy', Khanna Publishers, 2006.
2. Kothari P, K C Singal and Rakesh Ranjan, 'Renewable Energy Sources and Emerging Technologies', PHI Pvt. Ltd., New Delhi, 2008.

REFERENCE BOOKS:

1. Sukhatme S P and Nayak J K, 'Solar Energy - Principles of Thermal Collection and Storage', Tata McGraw Hill, 2008.
2. Frank Kreith and Yogi Goswami D, 'Handbook of Energy Efficiency and Renewable Energy', CRC Press, 2007.
3. Wakil M M H, "Power Plant Technology", McGraw Hill, 1984.
4. https://www.advanceelectricaldesign.com/Syllabus-EV-Charging-Station-Design-Training

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE132	**BATTERY MANAGEMENT SYSTEM**	**3**	**0**	**0**	**3**

COURSE CATEGORY: MINOR

PREAMBLE: This course deals with basics of batteries, working principle, safety standards, testing and recycling of batteries.

PREREQUISITE COURSES: Basic Electrical & Electronics Engineering

RELATED COURSES: EV Batteries & Charging System

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are,

- To learn about the basics concepts of Battery Management Systems (BMS) and it's requirements
- To understand the methods of battery state of charge and health estimation
- To know basic concepts and types of cell voltage balancing of battery cells
- To know about thermal management, safety aspects and standards
- To understand the concepts of battery testing, disposal and recycling.

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	Identify a BMS required for a particular battery type based on its application	K2
CO2	Estimate the remaining charge, voltage, power can be delivered by a battery, battery health, remaining useful life using various methods	K3
CO3	Solve the problems related to cell voltage balancing in battery cell level	K3
CO4	Describe the safety aspects and the concept of thermal management of batteries	K2
CO5	Explain the battery testing methods, disposal and recycling issues of batteries	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	M	H	L
CO2	H	H	M								L	M	H	L
CO3	H	H	M								L	M	H	L
CO4	H	M									L	M	H	L
CO5	H	M					M				L	M	H	L

COURSE CONTENT:		
UNIT I	**INTRODUCTION**	**9**
Introduction - General Battery Management System (BMS) - requirements - functionality -topology - Battery pack sensing: voltage-current-temperature - high voltage contactor control -isolation sensing - thermal control- charge and discharge control - protection and interfacing- range estimation - energy and power estimation.		
UNIT II	**STATE OF CHARGE AND STATE OF HEALTH ESTIMATION**	**9**
Need of State of Charge (SoC) and State of Health (SoH) estimation; resistive, ampere-hour counting, EMF measurement- over potential dependence- Total capacity- Equivalent Series Resistance(ESR) – Battery aging; corrosion on positive, negative electrode – power, capacity fading		
UNIT III	**CELL BALANCING**	**9**
Need of cell balancing -causes of imbalance - passive cell balancing- drawbacks – prediction of balance set point- real time balance- capacitor, inductor, transformer, converter, voltage multiplier based active cell balancing techniques – cell bypass, cell to cell, cell to pack, pack to cell balancing, quick balancing.		
UNIT IV	**THERMAL MANAGEMENT & SAFETY ASPECTS**	**9**
Battery thermal management - Thermal Runway - Passive cooling - Active cooling- mathematical analysis of cooling system - Causes of battery explosions - regulations and Safety Aspects of High Voltage Batteries - Codes and Standards - Safe handling of Lithium Batteries.		
UNIT V	**BATTERY TESTING, DISPOSAL & RECYCLING**	**9**
Methods of battery testing - selection of battery - limitations of energy storage in batteries - disposal and second use of batteries - leakage-rupture - gas generation in batteries - High discharge rates - short circuits - methods of recycling - General recycling issues .		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Rahn, Christopher D., and Chao-Yang Wang. 'Battery Systems Engineering'. John Wiley & Sons, 2013.
2. G-A. Nazri and G. Pistoa, 'Lithium Batteries, Science and Technology', Kluwer Academic Publisher, 2003.

REFERENCE BOOKS:

1. H. A. Kiehne, 'Battery Technology Handbook', Marcel Dekker, NYC, 2003.
2. James Larminie and John Lowry, 'Electric Vehicle Technology Explained', John Wiley, 2003.
3. D. Linden and T. S. Reddy, 'Handbook of Batteries',' 3rd Edition, McGraw-Hill, 2002.
4. D. A. J. Rand, R. Woods, and R. M. Dell, 'Batteries for Electric Vehicles', Society of Automotive Engineers, Warrendale, PA, 2003.
5. Kwade, Arno, and Jan Diekmann. 'Recycling of Lithium-Ion batteries' The LithoRec Way (2018).
6. Jiang, Jiuchun, and Caiping Zhang. 'Fundamentals and Applications of Lithium-Ion Batteries in Electric Drive Vehicles'. John Wiley & Sons, 2015.

COURSE CODE: **10213EE133**	COURSE TITLE: **ELECTRIC PROPULSION SYSTEM AND CONTROL**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: MINOR

PREAMBLE: This course aims in providing a guide to control of both AC and DC motors with a focus on its application to electric vehicle. It provides various field oriented control, Speed control and it also covers PWM techniques & inverters.

PREREQUISITE COURSES: Basic Electrical & Electronics Engineering

RELATED COURSES: Modelling and Simulation Of EV

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Understand the requirement of EV Motors
- Capability to analyze the Induction Motor characteristics and speed control methods
- Impart the knowledge of different types of sensor and their operations.

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 requirement of EV motors	K2
CO2	Explain the suitability of electric motor & their control	K2
CO3	Illustrate the speed control of Induction motor	K2
CO4	Outline the PWM techniques of Inverter for Induction motor.	K2
CO5	Summarize different sensors and sensor less operation of motor.	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	**MOTORS FOR EV AND ITS CHARACTERISTICS**	**9**
Requirement of EV motors- Comparison of EV motors-Basics of DC Motor-Torque speed characteristics- DC Motor dynamics-Field Weakening Control-Four quadrant operation		
UNIT II	**DC MOTOR DYNAMICS & CONTROL**	**9**
Current Loop Control-Speed Control Loop Dynamical System Control-Gain & Phase Margins-PD Controller-PI Controller-Selecting PI Gain for Speed Controller		
UNIT III	**INDUCTION MOTOR**	**9**
Rotating Magnetic Field- Basics of Induction motor- Speed &Torque Curve Leakage inductance-current displacement (double cage rotor)- line starting		
UNIT IV	**INDUCTION MOTOR SPEED CONTROL**	**9**
Rotating Magnetic Field- Basics of Induction motor- Speed-Torque Curve Leakage inductance-current displacement (double cage rotor)- line starting- Rotor Field oriented control- Stator Field Oriented Control- Field Weakening Control- Variable Voltage Variable Frequency Control		
UNIT V	**PWM and Inverter**	**9**
Sinusoidal PWM- Space Vector Modulation- Dead time &compensation- Encoders- Resolvers- R/D Converters- Hall current sensors and current sampling- Voltage Model Estimator- Current Model Estimator		
TOTAL: 45 PERIODS		

TEXT BOOKS:

1. JamesLarminie and John Lowry, 'Electric Vehicle Technology Explained' John Wiley &Sons, 2003
2. Iqbal Husain, 'Electric and Hybrid Vehicles-Design Fundamentals', CRC Press, 2003

REFERENCE BOOKS:

1. Mehrdad Ehsani, " Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press, 2005
2. K Wang Hee Nam 'AC Motor Control & Electrical Vehicle Application', CR Press, Taylor& Francis Group, 2019
3. C.C Chan, K.T Chau 'Modern Electric Vehicle Technology', Oxford University Press Inc., New York 2001.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE134	**HYBRID ELECTRIC VEHICLE TECHNOLOGIES**	**3**	**0**	**0**	**3**

COURSE CATEGORY: MINOR

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

PREREQUISITE COURSES: Basic Electrical & Electronics Engineering, Basic Mechanical & Construction Engineering

RELATED COURSES: Modelling and Simulation of EV

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- An overview of the vehicle propulsion principle
- An understanding of the electric vehicles and its power trains
- The fundamental knowledge on hybrid electric vehicles
- An elaborate knowledge on regenerative braking
- Broad analytical knowledge on advantages of electric vehicles on 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)
CO1	Enumerate the principle of vehicle propulsion and braking.	K2
CO2	Explain the structure of an electric vehicle.	K2
CO3	Illustrate the working principle of a Hybrid Electric Vehicle.	K2
CO4	Identify and solve the problems in regenerative braking.	K3
CO5	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	H	L
CO2	H	M	L								L	M	H	L
CO3	H	M	L								L	M	H	L
CO4	H	M	M								L	M	H	L
CO5	H	M	L								L	M	H	L

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 Drivetrains-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 Fuelled Vehicles		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Husain I. 'Electric and Hybrid Vehicles: Design Fundamentals'. CRC Press; 2011.
2. Larminie, James, and John Lowry. 'Electric Vehicle Technology Explained' John Wiley & Sons, Ltd, 2003.

REFERENCE BOOKS:

1. Ehsani, Mehrdad, YiminGao, and Ali Emadi. 'Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design'. CRC Press, 2009.
2. Emadi, Ali, 'Handbook of Automotive Power Electronics and Motor Drives' CRC Press, 2005.
3. Soylu, Seref. 'Electric Vehicles–Modelling and Simulations' InTech Europe, Rijeka, Croatia, 2011.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE135	**ENERGY STORAGE SYSTEMS AND CONTROL**	**3**	**0**	**0**	**3**

COURSE CATEGORY: MINOR

PREAMBLE: This course aims in providing the fundamental knowledge on Energy Storage system, Battery Characteristics, Battery modelling, Battery testing and Battery Management system.

PREREQUISITE COURSES: Basic Electrical & Electronics Engineering

RELATED COURSES: Battery Management System

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Provide the basic concepts of Energy Storage systems
- Impart fundamental knowledge on battery characteristics & parameters
- Understand overview of different types of battery
- Understand the battery testing, disposal and recycling.

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	Discuss about the types of energy storage system.	K2
CO2	Describe about the battery characteristic & parameters.	K2
CO3	Apply the concepts of battery management system and design the battery pack.	K3
CO4	Summarize the different types of batteries.	K2
CO5	Explain about the battery testing, disposal and recycling.	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	L								L	M	H	L
CO3	H	M	M								L	M	H	L
CO4	H	M	L								L	M	H	L
CO5	H	M	L				L				L	M	H	L

COURSE CONTENT:		
UNIT I	**ENERGY STORAGE SYSTEM**	**9**
Batteries: Lead Acid Batter- Nickel based batteries- Sodium based batteries- Lithium based batteries– Li-ion &Li-poly- Metal Air Battery-Zinc Chloride battery- Ultra capacitors- Flywheel Energy Storage System- Hydraulic Energy Storage System- Comparison of different Energy Storage System Suggested reading: Study of different types of batteries		
UNIT II	**BATTERY CHARACTERISTICS & PARAMETERS**	**9**
Cells and Batteries- conversion of chemical energy to electrical energy- Battery Specifications: Variables to characterize battery operating conditions and Specifications to characterize battery nominal and maximum characteristics- Efficiency of batteries- Electrical parameters Heat generation- Battery design-Performance criteria for Electric vehicles batteries- Vehicle propulsion factors- Power and energy requirements of batteries- Meeting battery performance criteria		
UNIT III	**BATTERY MODELLING**	**9**
General approach to modelling batteries- Model of a rechargeable Li-ion battery-Model of a rechargeable NiCd battery- Parameterization of the NiCd battery model		
UNIT IV	**BATTERY PACK AND BATTERY MANAGEMENT SYSTEM**	**9**
Selection of battery for EVs & HEVs- Traction Battery Pack design-Requirement of Battery Monitoring		
UNIT V	**BATTERY TESTING, DISPOSAL & RECYCLING**	**9**
Chemical & structure material properties for cell safety and battery design- battery testing- limitations for transport and storage of cells and batteries- Recycling- disposal and second use of batteries- General recycling issues -Methods of recycling of EV batteries		
TOTAL: 45 PERIODS		

TEXT BOOKS:

1. Ibrahim Dinçer, Halil S. Hamut and Nader Javani, 'Thermal Management of Electric Vehicle Battery Systems', John Wiley& Sons Ltd., 2016.
2. Chris Mi, AbulMasrur & David Wenzhong Gao, 'Hybrid Electric Vehicle- Principles & Applications with Practical Properties', Wiley, 2011.

REFERENCE BOOKS:

1. James Larminie, John Lowry, 'Electric Vehicle Technology Explained', John Wiley &Sons Ltd, 2003.
2. G. Pistoia, J.P. Wiaux, S.P. Wolsky, 'Used Battery Collection and Recycling', Elsevier, 2001. (ISBN: 0-444-50562-8)
3. T R Crompton, 'Battery Reference Book', 3rd Edition, Newnes Reed Educational and Professional Publishing Ltd., 2000.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE136	**MODELLING AND SIMULATION OF EV**	**2**	**0**	**2**	**3**

COURSE CATEGORY: MINOR

PREAMBLE: This course aims in providing the Knowledge on Modelling and Simulation level of Electric Vehicle.

PREREQUISITE COURSES: Basic Electrical & Electronics Engineering

RELATED COURSES: Hybrid Electric Vehicle Technologies, Battery Management System

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Impart fundamental knowledge on technical parameters of batteries, battery charger, types of fuel cells.
- Impart analytical knowledge on modelling and Simulation of Hybrid Electric 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)
CO1	Elaborate various technical parameters of batteries	K2
CO2	Compare types of batteries used for EV applications.	K2
CO3	Develop battery charger for an EV	K3
CO4	Interpret the applications of super capacitors for appropriate storage systems.	K2
CO5	Classify the types of 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	H	M	L	M						M	M	H	M
CO2	H	H	M	L	M						M	M	H	M
CO3	H	H	M	L							M	M	H	M
CO4	H	H	M	L	L						M	M	H	M
CO5	H	M	L								M	M	H	M

COURSE CONTENT:		
UNIT I	**MODELLING OF VEHICLE PERFORMANCE PARAMETER**	**6**
Modeling Vehicle Acceleration - Acceleration performance parameters- modeling the acceleration of an electric scooter- modeling the acceleration of a small car.		
UNIT II	**MODELLING AND SIMULATION OF HYBRID AND ELECTRIC VEHICLES**	**15**
Electric Vehicle Modelling - Tractive Effort- Rolling resistance force- Aerodynamic drag- Hill climbing force- Acceleration force- Total tractive effort- Modelling Electric Vehicle Range -Driving cycles-Range modelling of battery electric vehicles- Constant velocity range modelling-Range modelling of fuel cell vehicles- Range of Electric vehicles.		
UNIT III	**DRIVETRAIN CHARACTERISTICS**	**15**
Modelling and Characteristics of EV Power trains Components - Electric Motor Performance Characteristics - Battery Performance Characteristics-Transmission and Drive train Characteristics		
UNIT IV	**ENERGY MANAGEMENT**	**15**
Handling Analysis of Electric Vehicles- Simplified Handling Models Energy/Power Allocation and Management - Power/Energy Management Controllers – Rule Based Control Strategies - Optimization-Based Control Strategies Simulation study – Energy Management control of electric vehicles.		
UNIT V	**FUEL CELLS**	**9**
Control of Electric Vehicle Dynamics - Fundamentals of Vehicle Dynamic Control (VDC) Systems-VDC Implementation on Electric Vehicles – Case Studies- Rechargeable Battery vehicles, Fuel Cell Powered Bus.		
		TOTAL: 60 PERIODS

TEXT BOOKS:

1. Amir Khajepour, Saber Fallah and Avesta Goodarzi, 'Electric and Hybrid Vehicles Technologies, Modelling and Control: A Mechatronic Approach', John Wiley &Sons Ltd, 2014.
2. Antoni Szumanowski, 'Hybrid Electric Power Train Engineering and Technology: Modelling, Control, and Simulation', IGI Global, 2013

REFERENCE BOOKS:

1. MehrdadEhsani, YiminGao, Ali Emadi, 'Modern Electric, Hybrid Electric, and Fuel Cell Vehicles Fundamentals, Theory, and Design', 2nd Edition, CRC Press, 2010.
2. James Larminie, John Lowry, 'Electric Vehicle Technology Explained', John Wiley &Sons Ltd, 2003.

Minor Degree in
Renewable Energy Sources

List of Courses (18 Credits)

S.No.	Course Code	Lecture Courses	L	T	P	C
1	10213EE141	Renewable Energy	3	0	0	3
2	10213EE142	Wind Energy Conversion Systems	3	0	0	3
3	10213EE143	Solar Photovoltaics: Fundamentals, Technology and Applications	3	0	0	3
4	10213EE144	Conversion of Energy in Buildings	3	0	0	3
5	10213EE145	Solar Thermal Energy Systems	3	0	0	3
6	10213EE146	Distributed Generation and Integration of Renewable Energy with Grid	3	0	0	3

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE141	**RENEWABLE ENERGY**	**3**	**0**	**0**	**3**

COURSE CATEGORY: MINOR

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 & Electronics Engineering

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- 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 its importance.	K2
CO2	Outline the process of photovoltaic power generation.	K2
CO3	Outline the process of power generation using wind energy sources.	K2
CO4	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
CO1											L	L
CO2		H	H					M	M			
CO3		H										
CO4			H		H	L	H				L	L
CO5		L			L			M	M		L	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
2. Sukhatme S P and Nayak J K, 'Solar Energy - Principles of Thermal Collection and Storage', Tata McGraw Hill, 2008.

REFERENCE BOOKS:

1. Kothari P, K C Singal and Rakesh Ranjan, 'Renewable Energy Sources and Emerging Technologies', PHI Pvt. Ltd., New Delhi, 2008.
2. Frank Kreith and Yogi Goswami D, 'Handbook of Energy Efficiency and Renewable Energy', CRC Press, 2007.
3. Abbasi S A and Naseema Abbasi, 'Renewable Energy Sources and their Environmental Impact', PHI Private Limited, 2001.
4. Wakil M M H, 'Power Plant Technology', McGraw Hill, 1984.

COURSE CODE: 10213EE142	COURSE TITLE: WIND ENERGY CONVERSION SYSTEMS	L	T	P	C
		3	0	0	3

COURSE CATEGORY: MINOR

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

COURSE EDUCATIONAL OBJECTIVES:

- To learn about Power extraction from wind energy
- To distinguish the components and design of wind tower
- To 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	Fundamentals of wind energy conversion	K2
CO2	Types of wind turbines and aerodynamics	K2
CO3	Components of wind turbine and its construction	K2
CO4	Explain the principle of operation of Types of generators	K2
CO5	Wind turbine control and monitoring system	K2

CORRELATION OF COs WITH POs AND PSOs

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

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 - Up wind-Down wind - 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		

TEXTBOOKS:

1. VVN Kishore 'Renewable Energy Engineering and Technology – A Knowledge Compendium', TERI Press, 2008.
2. Martin OL Hansen 'Aerodynamics of Wind Turbines', 2nd Edition, Earthscan, London.
3. B.H.Khan: Non-Conventional Energy Sources, Tata McGraw-Hill Education, 2006.

REFERENCE BOOKS:

1. Johnson, G.L., 'Wind Energy Systems', Prentice Hall, 1985.
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.

COURSE CODE: 10213EE143	COURSE TITLE: SOLAR PHOTOVOLTAICS: FUNDAMENTALS, TECHNOLOGY AND APPLICATIONS	L	T	P	C
		2	0	2	3

COURSE CATEGORY: Minor Degree Course

PREAMBLE: This course offer a basic knowledge on solar Photovoltaic technology and Systems comprising up of the fundamentals, design and application of solar photovoltaic systems for power generation on small and large scale electrification.

PRE-REQUISITES: Basic Electrical Engineering

COURSE EDUCATIONAL OBJECTIVES:

To impart knowledge on

- To familiar with basics of solar PV
- To familiar with various PV performance measure terminologies.
- To understand about manufacturing of PV cells & sizing aspects of PV systems.
- To understand about PV system components and apply them in installation practices& associated trouble shootings.
- To understand about PV system applications & 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	Understand the principle of direct solar energy conversion to power using PV	K2
CO2	Contrast the performance measures of PV	K2
CO3	Infer on various solar cells & design aspects of solarPV	K2
CO4	Identify various PV components & construct few systems	K2
CO5	Develop ideas for working on solar PV systems & associated safety practices	K2

CORRELATION OF COs AND POs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H									H		
CO2	H	M	M							H		H
CO3	H			H						H		H
CO4	H	M		H						H		
CO5	H									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: 30 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.

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 Edition, Wiley, 2010.

LABORATORY PRACTICES (15 PERIODS)

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
10213EE144	**CONSERVATION OF ENERGY IN BUILDINGS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: MINOR

PREAMBLE: The main objective of this course is to make the students to understand the concepts of energy conservation concepts in buildings by learning the design of energy efficient buildings and energy conservation act.

PREREQUISITE COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- Introduction to energy conservation technology
- Explain in detail about waste heat recovery system
- Energy efficiency improvement in buildings
- Discuss in detail about energy conservation act.
- Renewable energy generation in buildings.

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	Introduction to energy conservation technology	K2
CO2	Explain in detail about waste heat recovery system	K2
CO3	Energy efficiency improvement in buildings	K2
CO4	Discuss in detail about energy conservation act.	K2
CO5	Renewable energy generation in buildings.	K2

CORRELATION OF COs AND POs

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

COURSE CONTENT:

UNIT I	GENERAL ASPECTS	9

Introduction, Approach and modern techniques, benefits, trends, Energy Conservation Technology, Energy Conservation in Energy Intensive Industries, Techno-Economic evaluation of conservation technologies, Efficiency Improvements Thermal Utilities, Heating and Melting Applications, Refractories.

UNIT II	WASTE HEAT RECOVERY	9
Sources of waste heat and its potential applications, Waste heat survey and measurements, Data collection, Limitations and affecting factors Heat recovery equipment and systems, Heat Exchangers, Incinerators Regenerators and Recuperates, system Integration.		
UNIT III	**ENERGY EFFICIENCY IN BUILDINGS**	**9**
Adoption to sustainable resources, process and Technologies, Green Buildings, Intelligent Buildings, Rating of Buildings, Efficient Use of Buildings, Solar Passive Architecture, Eco-housing concepts and National and International norms.		
UNIT IV	**ENERGY CONSERVATION & ACT**	**9**
Energy conservation act 2001, salient features, Ministry of New and Renewable Energy (MNRE), National Product Council (NPC), Bureau of Energy Efficiency (BEE), Net metering, ECBC (Energy Conservation Building Code)-2017.		
UNIT V	**RENEWABLE ENERGY GENERATION IN BUILDINGS**	**9**
Model of solar power plant, wind power plant, energy consumption calculation in buildings, design of energy efficient solar buildings, design of grid connected renewable energy sources, energy storage requirements, selection of renewable energy sources based on location.		
TOTAL: 45 PERIODS		

TEXT BOOKS:

1. Rai G D, 'Non-Conventional Sources of Energy', Khanna Publishers, 2006.
2. Sukhatme S P and Nayak J K, 'Solar Energy - Principles of Thermal Collection and Storage', Tata McGraw Hill, 2008.

REFERENCE BOOKS:

1. Kothari P, K C Singal and Rakesh Ranjan, 'Renewable Energy Sources and Emerging Technologies', PHI Pvt. Ltd., New Delhi, 2008.
2. L.C. Witte, P.S. Schmidt, D.R. Brown, 'Industrial Energy Management and Utilisation', Hemisphere Publication, Washington.
3. Energy Conservation guide book Patrick/Patrick/Fardo (Prentice Hall)
4. Abbasi S A and Naseema Abbasi, 'Renewable Energy Sources and their Environmental Impact', PHI Private Limited, 2001.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE145	**SOLAR THERMAL ENERGY SYSTEMS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: MINOR

PREAMBLE: Introduction about solar thermal energy conversion systems, energy collectors, solar thermal energy storage devices, applications of solar thermal energy and cost estimation for solar plant implementation.

PREREQUISITE COURSES: Basic Electrical & Electronics Engineering.

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- Introduction about solar thermal energy conversion systems
- Explain about types of energy collectors and its performance
- Understand in detail about solar thermal energy storage systems
- Outline about Practical applications of solar thermal energy
- Explain about the cost estimation and installation related issues of solar thermal energy conversion

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	Discuss about types of solar thermal energy conversion systems	K2
CO2	Explain about working of energy collectors and its performance	K2
CO3	Understand in detail about solar thermal energy storage systems	K2
CO4	Understand the practical applications of solar thermal energy	K2
CO5	Explain about the cost estimation and installation related issues of solar thermal energy conversion	K2

CORRELATION OF COs AND POs

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

COURSE CONTENT:		
UNIT I	**INTRODUCTION**	**9**
Devices for thermal collection and storage, Thermal applications, Extra-terrestrial and terrestrial solar radiation, Instruments for measuring solar radiation and sunshine, Solar radiation data, Solar radiation geometry, Empirical equations for predicting the availability of solar radiation and solar radiation on tilted surface.		
UNIT II	**ENERGY COLLECTORS**	**9**
Basic concept of liquid flat plate collectors, Concentrating collectors, Flat-plate collectors with plane reflectors, Cylindrical parabolic collector, Performance analysis, Transmissivity of the cover system, Overall loss coefficient and heat transfer correlations, Collector efficiency factor, Collector heat removal factor, Compound parabolic collector, Parabolic dish collector, Central receiver collector.		
UNIT III	**ENERGY STORAGE**	**9**
Introduction to thermal energy storage, sensible and latent heat storage, Thermo chemical storage, Basic concept and principle of working of solar pond, Description, Performance analysis, Operational problems, Other solar pond concepts.		
UNIT IV	**APPLICATIONS**	**9**
Introduction to solar air heater, Performance analysis of conventional air heater, other types of air heaters, Solar thermal energy for cooling, refrigeration and air conditioning, thermal desalination, agriculture applications, domestic and industrial applications.		
UNIT V	**COST ESTIMATION**	**9**
Simple payback period, return on investment, net present value, internal rate of return, cash flows and sensitivity analysis, Financing options, energy performance contracts and role of ESCOs, Project definition and scope, technical design and Financing, Project planning techniques; CPM and PERT.		
TOTAL: 45 PERIODS		

TEXT BOOKS:

1. Means .R.S, 'Green Building: Project Planning and Cost Estimating', Kingston, 2006.
2. Kibert .C.J. 'Sustainable Construction: Green Building Design', 2nd Edition, Wiley, 2007.

REFERENCE BOOKS:

1. Boecker .J, 'Integrative Design Guide to Green Building', Wiley, 2009.
2. Eicker .U, 'Low Energy Cooling for Sustainable Buildings', Wiley, 2009.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10213EE146	**DISTRIBUTED GENERATION AND INTEGRATION OF RENEWABLE ENERGY WITH GRID**	**3**	**0**	**0**	**3**

COURSE CATEGORY: MINOR

PREAMBLE: This course aims to give complete knowledge about distributed generation of renewable energy sources and integration issues of hybrid renewable energy sources with grid.

PREREQUISITE COURSES: Basic Electrical & Electronics Engineering

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- Understand about distributed and grid connected energy generation
- Working concept of multiple renewable energy generation systems
- Grid integration issues of renewable energy generation

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	Understanding about distributed and grid connected energy generation	K2
CO2	Explain about the working of turbine generators for different renewable energy sources	K2
CO3	Discuss about distributed generation and equipment's required	K2
CO4	Renewable energy with grid integration and its issues	K2
CO5	Hybridization of multiple renewable energy resources with grid	K2

CORRELATION OF COs AND POs

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

COURSE CONTENT:		
UNIT I	**INTRODUCTION**	**9**
Distributed Generation System: Decentralized versus Central Station generation, Traditional, power systems, Load curves and Load curve analysis. Coincidence behaviour and Load curves measuring load curve data accurately Planning and Planning Process: Planning finding the best alternative, Short and long range planning. Cost and Economic Evaluation of Distributed Generation: Costs, time value of money, decisions bases and cost effectiveness evaluation.		
UNIT II	**ENERGY GENERATION**	**9**
Basic gas turbine generator concepts: Utility system turbine generators; Mini and micro gas turbine generators Solar thermal power generations, Utility Scale PhotoVoltaic (USPV) generation; Wind powered generation; Biomass based generation.		
UNIT III	**DISTRIBUTED GENERATION**	**9**
DG Evaluation: Cost from past, present, and future, basic DG cost analysis, cost evaluation and schedule of demand, AC and DC power generation – energy and storage requirement calculations – converter, inverter, controller requirements.		
UNIT IV	**GRID INTEGRATION**	**9**
Grid Interconnection Issues and Need of Integration of Renewable Energy: The power grid, Pro & cons of DG-interconnections, type of DG grid interconnection, DG-Grid interconnections issues - Effects on the grid by RE systems integration; Interfacing techniques; Innovations required in technology and policy Economics: Grid-connected energy storage schemes; response requirement, capacity assessment, cost considerations.		
UNIT V	**HYBRID SOURCE INTEGRATION**	**9**
Hybrid Energy Systems: types, integration issues of hybrid energy generation with grid, Principles and applications; comparison of schemes; System design concept: Techno-economic performance; Energy storage schemes and estimation.		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Willis H Lee, 'Distributed Power Generation: Planning and Evaluation', Marcel Dekker, Inc.
2. Willis H Lee, 'Power Distribution Planning Reference Book', Marcel Dekker, Inc.

REFERENCE BOOKS:

1. Ali Keyhani, Mohammad N Marwali, Min Dai, 'Integration of Green and Renewable Energy in Electric Power Systems', Wiley.
2. Kaushik N D, Kaushik Kshitij, 'Energy Ecology and Environment: A Technological Approach', New Delhi, Capital Publishing Company.

B.Tech. Programme
in
Electrical and Electronics Engineering with Honors in Smart Grid Technologies

List of Courses (18 Credits)

Sl.No.	Course Code	Lecture Courses	L	T	P	C
1	10212EE171	Smart Grid	3	0	0	3
2	10212EE172	Energy Management and SCADA	3	0	0	3
3	10212EE173	Power System Restructuring	3	0	0	3
4	10212EE174	Distributed Generation and Micro Grid	3	0	0	3
5	10212EE175	IoT Applications in Smart Grid	3	0	0	3
6	10212EE176	AI for Smart Grid Systems	3	0	0	3

COURSECODE:	COURSE TITLE:	L	T	P	C
10212EE171	**SMART GRID**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Honors

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 make the students,

- To understand the basic concepts, components and architecture of smart grid.
- To understand the various communication technologies in smart grid.
- To understand the various measurement smart energy meters in smart grid.
- To understand the power quality measurement in smart grid.
- To brief about role of Renewable Energy Storage and 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	Explicate the need of smart grid technology and characteristics of transmission grid	K2
CO2	Describe the concept of communication technologies of smart grid	K2
CO3	Exemplify the smart meters, sensors and their role in smart grid	K2
CO4	Analyse the power quality measurement in smart grid	K2
CO5	Analyse the renewable energy storage and electric vehicle for 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	H		M		M			M					M	H
CO2	H	M						M					M	H
CO3	H			M	M			M					M	H
CO4	H	M	M		M			M					M	H
CO5	H			M				M					M	H

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, Present development & International policies in Smart Grid, Architecture of smart grid, Functions of smart grid components, characteristics of Smart Transmission Grid.

UNIT II	COMMUNICATION TECHNOLOGIES TO SMART GRID	9

Introduction to Smart grid communication network, IEEE P2030 communication model, Services supported in a Smart Grid communication network, Communications Technologies available for Smart Grids, Mobile communications, Power line communication, Comparison of communication Technologies, Smart Grid Communications Requirements- Security-System reliability. Smart grid communication standards.

UNIT III	SMART METERS AND SENSORS	9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI needs in the smart grid, Phasor Measurement Unit (PMU), Functional requirements of PMUs, Intelligent Electronic Devices (IED) & their application for monitoring & protection, Wide Area measurement system (WAMS), Sensors for Smart Grid.

UNIT IV	POWER QUALITY MEASUREMENT IN SMART GRID	9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit, Optimization techniques and applications to smart grid.

UNIT V	RENEWABLE ENERGY STORAGE AND ELECTRIC VEHICLE	9

Benefits of renewable generation, Importance of micro grid, Demand response issues, Energy storage technologies, Grid integration issues of renewable energy sources. Vehicle Architecture, PHEV technology

TOTAL: 45 PERIODS

TEXTBOOKS:

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, Akihi kookoyam 'Smart Grid: Technologyand Applications', John Wiley Sons Inc, 2012.

REFERENCE BOOKS:

1. Fereidoon P.Sioshansi, 'Smart Grid: Integrating Renewable, Distributed & Efficient Energy', Academic Press, 2012
2. Stuart Borlase, 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press, 2016
3. Lars T. Berger and Krzysztof Iniewski, 'Smart Grid Applications, Communications, and Security', John Wiley & Sons, 2012.
4. Clark W. Gellings, 'The Smart Grid- Enabling Energy Efficiency and Demand Response', CRC Press, 2009

COURSECODE:	COURSE TITLE:	L	T	P	C
10212EE172	**ENERGY MANAGEMENT AND SCADA**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Honors

PREAMBLE: This course provides an update, to the knowledge base of the students, in essential Energy Management. Students may gain knowledge on Energy Auditing, Lighting systems and Maintenance of Energy Systems and application of SCADA with the associated economic benefits.

PREREQUISITE COURSES: Power System Analysis

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- Understand the fundamentals of energy management functions
- Understand the economic analysis and system energy management for electrical system and equipment.
- Enhance the knowledge in lighting and cogeneration.
- Expose to the concept of supervisory control and data acquisition.
- Familiarize the application of SCADA in power 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	Understand the concept of Energy Management functions, and energy audit process	K2
CO2	Understand the principle of economic analysis and system energy systems	K2
CO3	Understand the Energy Conservation options in Lighting and its control	K2
CO4	Understand the importance of SCADA and functional requirements	K2
CO5	Understand the SCADA applications and wide area protections	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						H		M		M	L
CO2	H								H		M		M	L
CO3	H		M						M		M		M	L
CO4	H								H		M		M	M
CO5									H		M		M	M

COURSE CONTENT:

UNIT I	ENERGY MANAGEMENT FUNCTION	9

Need for energy management – energy management program,Energy accounting – Energy monitoring, Targeting and Reporting, Energy audit process, Energy Management centers and their Functions, Architectures of centers and their Functions, Energy performance assessment of HVAC system.

UNIT II	ECONOMIC ANALYSIS AND SYSTEM ENERGY MANAGEMENT	9

Important concepts in an economic analysis, Electricity tariff, Electrical Load Management and Maximum Demand Control, Systems and equipment, Electric motors, Transformers, Capacitors -power factor and effect of harmonics on power quality, Energy efficiency analysis on electrical power system, motor and transformer.

UNIT III	LIGHTING AND COGENERATION	9

Concept of lighting systems – the task and the working space, Light sources – ballasts –luminaries, lighting controls, Optimizing lighting energy, lighting and energy standards, Forms of cogeneration – Feasibility of cogeneration, Energy performance analysis of lighting and cogeneration.

UNIT IV	SUPERVISORY CONTROL AND DATA AQUISITION	9

SCADA - Functional requirements and Components, General features, Functions and Applications, Benefits, Various SCADA architectures, SCADA Communication: various industrial communication technologies

UNIT V	SCADA APPLICATIONS	9

SCADA Applications: Utility Applications, Transmission and distribution sector-Operations, Monitoring, Analysis and improvement, Substation automation structure, Substation automation architecture, Introduction to wide area protection.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Stuart A. Boyer 'SCADA - Supervisory Control and Data Acquisition', Instrument Society of America Publications, USA, The Instrumentation system and Automation Society, 4th Edition, 2010
2. Gordon Clarke, Deon Reynders 'Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems', Newnes An Imprint of Elsevier Publications, 1st Edition, 2004

REFERENCE BOOKS:

1. Wayne C. Turner, Steve Doty 'Energy Management Hand Book', The Fairmont Press, 6th Edition, 2007
2. Amit K. Tyagi, 'Handbook on Energy Audits and Management', Tata Energy Research Institute, 2nd Reprint, 2003

COURSECODE:	COURSE TITLE:	L	T	P	C
10212EE173	**POWER SYSTEM RESTRUCTURING**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Honors

PREAMBLE: To provide depth knowledge about the concepts of power system load flow analysis, fault analysis and stability analysis with its solution techniques.

PREREQUISITE COURSES: Power System Analysis

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- To understand the operation of restructured power system and key issues in electric utilities restructuring.
- To understand the issues related to Restructuring and about transmission management, congestion management
- To understand the basic architecture, transfer capability issues and transmission services.
- To understand the essence of electric energy trading, volatility, risk and pricing
- To understand about the technical challenges in restructuring

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	Elucidate the concept of Deregulation, different entities	K2
CO2	Explain the concept of market structures and bidding	K2
CO3	Explain the transmission pricing issues and Ancillary services	K2
CO4	Explain the Ancillary services management	K2
CO5	Address the technical challenges in Restructuring	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		M	M
CO2	M		M								M		M	M
CO3	M								M				M	M
CO4	M		M						M		M		M	M
CO5	M										M		M	M

COURSE CONTENT:

UNIT I	**DEREGULATION OF ELECTRIC SUPPLY INDUSTRY**	**9**

Introduction about deregulation – Structure of restructured electric utility – Different entities – Deregulation situation around the world (Qualitative treatment) – Benefits from competitive electricity market – After effects of deregulation. Role of Load Managers.

UNIT II	**POWER SYSTEM OPERATION IN COMPETITIVE ENVIRONMENT**	**9**

Role of ISO – Comparison of two different market structures – Operational planning activities of ISO – ISO in bilateral markets – Operational planning activities of GENCO – GENCO in pool and bilateral markets – Market participation issues – Competitive bidding.

UNIT III	**TRANSMISSION OPEN ACCESS AND PRICING ISSUES**	**9**

Power wheeling – Types of transmission services in open access – Cost components in transmission – Pricing of power transactions – Pricing mechanisms in various countries.

UNIT IV	**ANCILLARY SERVICES MANAGEMENT**	**9**

General description of some ancillary services – Ancillary service management in various countries – Reactive power as an ancillary service – Synchronous generators as ancillary service providers

UNIT V	**TECHNICAL CHALLENGES AND AVAILABILITY BASED TARIFF**	**9**

Total transfer capability – Limitations - Margins – Available transfer capability (ATC) – Procedure - Methods to compute ATC – Static and Dynamic ATC –Concept of Congestion Management – Bid, Zonal and Node Congestion Principles - Generation Rescheduling,beneficiaries and applications

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Kankar Bhattacharya, Math H.J. Bollen and Jaap E. Daalder, 'Operation of Restructured Power Systems', Kluwer Academic Publishers, 2001.
2. Loi Lei Lai, 'Power system Restructuring and Deregulation', John Wiley Sons, 2001.

REFERENCE BOOKS:

1. Shahidehpour.M and Alomoush.M, 'Restructuring Electrical Power Systems', Marcel Decker Inc., 2001.
2. M.Illic, F.Galiana and L.Fink, 'Power Systems Restructuring: Engineering and Economics', Kluwer Academic Publishers, 2000.

COURSECODE:	COURSE TITLE:	L	T	P	C
10212EE174	**DISTRIBUTED GENERATION AND MICRO GRID**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Honors

PREAMBLE: Distributed Generation system would provide the platform for the use of renewable sources which are the key to a sustainable energy supply infrastructure. The course aims at giving an adequate exposure in distributed generation systems, economics of distributed resources, and Photovoltaic Systems, State of the art of hybrid systems and major issues of connecting DG into the system.

PREREQUISITE COURSES: Renewable Energy Sources, Power System Analysis

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- The concept of distributed generation with their effect on distribution system
- The impact of grid integration and its technical aspects
- The concept of Micro grid and its configuration
- The operating modes and control concepts of micro 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	Recognize the need of sitting and sizing of distributed generation along with their effect on distribution system.	K2
CO2	Analyze the requirements for grid integration and standards	K2
CO3	Explain the stability and power quality issues on the system due to DGs	K2
CO4	Explicate the configuration and structure of AC and DC micro grids	K2
CO5	Describe the operational and control concepts of micro 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	H						M						H	M
CO2	H	M		M		M	M						H	M
CO3	M												H	M
CO4	H	M		M			M						H	M
CO5	H						M						H	M

COURSE CONTENT:

UNIT I	NEED FOR DISTRIBUTED GENERATION	9

Renewable sources in distributed generation – Current scenario in distributed generation – Planning of DGs – Siting and sizing of DGs – Optimal placement of DG sources in distribution systems.

UNIT II	GRID INTEGRATION OF DGS	9

Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations. Basics of Energy storage elements: Batteries, ultra-capacitors, flywheels.

UNIT III	TECHNICAL IMPACTS OF DGS	9

Requirements for grid interconnection, limits on operational parameters, voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

UNIT IV	BASICS OF MICROGRID	9

Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids.

UNIT V	CONTROL AND OPERATION OF MICROGRID	9

Modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication-based techniques, microgrid communication infrastructure, Power quality issues in micro grids.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. H. Lee Willis, Walter G. Scott, 'Distributed Power Generation – Planning and Evaluation', Marcel Decker Press, 2000.
2. Robert Lasseter, Paolo Piagi, 'Micro-grid: A Conceptual Solution', PESC 2004, June 2004.

REFERENCE BOOKS:

1. F. Katiraei, M.R. Iravani, 'Transients of a Micro-Grid System with Multiple Distributed Energy Resources', International Conference on Power Systems Transients (IPST'05) in Montreal, Canada on June 19-23, 2005.
2. Bollen M.H. and Hassan F. (2011); Integration of Distributed Generation in the Power System, Wiley-IEEE Press
3. Nikos Hatziargyriou, "Microgrids: Architectures and Control", ISBN: 978-1-118- 72068-4, December 2013, Wiley-IEEE Press.
4. M.GodoySimoes, Felix A.Farret, 'Renewable Energy Systems – Design and Analysis with Induction Generators', CRC press.
5. Keyhani A. (2011); 'Design of Smart Power Grid Renewable Energy Systems', Wiley–IEEE Press

COURSECODE:	COURSE TITLE:	L	T	P	C
10212EE175	**IoT APPLICATIONS IN SMART GRID**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Honors

PREAMBLE: To enable the students acquire knowledge on IoT, different options of communication technologies and measurement technology for various aspects of smart grid.

PREREQUISITE COURSES: Power System Analysis

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- The emerging area of Internet of Things and Smart Grid.
- Internet of Things and Smart Grid 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	Describe the concepts of Internet of Things and Smart Grid	K2
CO2	Explain the IoT technologies and communication technologies	K2
CO3	Explicate the applications of HAN, NAN and WAN	K2
CO4	Spell out the suitable architectures for IoT aided Smart grid systems	K2
CO5	Enumerate the suitable architecture, possible applications and existing prototypes of IoT aided smart grid 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				M						H	M
CO2	H						M						H	M
CO3	H		H										H	M
CO4	H			H		H	M						M	M
CO5	H						M						M	M

COURSE CONTENT:

UNIT I	IOT AND SMART GRID	9

Internet of Things - Smart Grid- Importance of Smart Grid in Smart Cities-Integration of the Internet of Things into a Smart Grid.

UNIT II	IoT ANDCOMMUNICATION TECHNOLOGIES	9

IoT Technologies – Communication Technologies: Home Area Network (HAN) - Neighbourhood Area Network (NAN)- Wide Area Network (WAN), Activities in IoT, Smart Grid and IoT aided Smart grid systems.

UNIT III	APPLICATIONS OF IOTAIDED SMART GRID SYSTEMS	9
HAN applications: Smart Home – Electric vehicle – AMI – Integration of DERs – Power demand management- NAN applications: Smart Distribution – smart patrol – WAN applications: Transmission tower protection – monitoring of power transmission lines.		
UNIT IV	**ARCHITECTURES FOR IOT AIDED SMART GRID SYSTEMS**	**9**
Smart Grid Architecture Model – Three layered architecture – Four layered architecture – Cloud based architecture – Web enabled smart grid architecture – Last meter smart grid architecture.		
UNIT V	**PROTOTYPES FOR IOT AIDED SMART GRID SYSTEMS**	**9**
A Simple Prototype for Energy Efficiency- Integration of Renewable and Non-Renewable energy Sources at Home- In Home Appliance Monitoring Implementation- Real time Monitoring of Medium Voltage Grid – Open issues & challenges.		
TOTAL: 45 PERIODS		

TEXTBOOKS:

1. P. Waher, 'Learning Internet of Things' Packt Publishing, 2015.
2. N. Ramesh Babu, 'Smart Grid Systems: Modeling and Control', CRC Press, 2018.

REFERENCE BOOKS:

1. D. Kellmereit, 'The Silent Intelligence: The Internet of Things' DnD Ventures, 2013.
2. F. P. Sioshansi, 'Smart Grid: Integrating Renewable, Distributed and Efficient Energy', Academic Press, 2011.
3. A. McEwen and H. Cassimally, 'Designing the Internet of Things' John Wiley & Sons, 2013.
4. S. Borlase, 'Smart Grids: Advanced Technologies and Solutions', 2nd Edition. CRC Press, 2017.

COURSECODE:	COURSE TITLE:	L	T	P	C
10212EE176	**AI FOR SMART GRID SYSTEMS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Honors

PREAMBLE: To enable the students acquire knowledge on artificial intelligent, different options of programming language related to emerging technology for various aspects of smart grid.

PREREQUISITE COURSES: Power System Engineering

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- To understand the principles and approaches of artificial intelligence (AI)
- To convey the ideas in AI research and programming language related to emerging technology.
- To expose the real-world applications of AI

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	Explore the fundamental concepts in Artificial Intelligence	K2
CO2	Explain the AI technologies and solving problems in real world	K2
CO3	Describe the applications of pattern recognition and its application	K2
CO4	Explain the artificial neural networks and different learning	K2
CO5	Enumerate the possible applications and existing prototypes of AI aided smart grid 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				M							
CO2	H						M							
CO3	H		M											
CO4	H			M		M	M							
CO5	H						M							

COURSE CONTENT:

UNIT I	INTRODUCTION TO AI	9

Definition, Applications, Components of an AI program, production system, Problem Characteristics, overview of searching techniques. Knowledge representation: Knowledge representation issues, and overview. Representing knowledge using rules; procedural versus declarative knowledge. Logic programming, forward versus backward reasoning, matching control knowledge.

UNIT II	AI TECHNOLOGIES	9

Problem Representation and Schemes- Problem Solving in AI- Blind Search Techniques- Heuristic Search Techniques- Game Searches- Computer Vision- Natural Language Processing- Speech Recognition.

UNIT III	PATTERN RECOGNITION	9

Introduction, automatic pattern recognition scheme. Design Concepts, Methodologies, Concepts of Classifier, concept of feature selection. Feature selection based on means and covariances. Statistical classifier design algorithms; increment--correction and LMSE. Algorithms, Applications.

UNIT IV	ARTIFICIAL NEURAL NETWORKS	9

Biological Neuron, Neural Net, use of neural 'nets, applications, Perception, idea of single layer and multilayer neural nets, back--propagation, Hopfield nets, supervised and unsupervised learning, reinforcement learning.

UNIT V	APPLICATIONS OF ARTIFICIAL INTELLIGENCE	9

Case-Based Reasoning- Applications of CBR Systems- Constraint Programming- AI Applications: E-Commerce, E-Tourism, Industry, case study of smart grid

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Kevin Warwick, Arthur Ekwue and Raj Aggarwal, ‘Artificial Intelligence Techniques in Power Systems’, The Institution of Electrical Engineers, 1997.
2. Rajendra Akerkar, ‘Introduction to Artificial Intelligence’ 2nd Edition, Prentice-Hall India Pvt. Ltd., 2014.

REFERENCE BOOKS:

1. MariuszFlasiński, ‘Introduction to Artificial Intelligence’, Springer,2016
2. Wolfgang Ertel, ‘Introduction to Artificial Intelligence’, Springer, 2017.
3. Eugene Charniak, ‘Introduction to Artificial Intelligence’, Pearson Education, 2016
4. N. P. Padhy, ‘Artificial Intelligence and Intelligent Systems’, Oxford University Press, 2005.
5. Sergios Theodoridis, Konstantinos Koutroumbas ‘Pattern Recognition’, Elsevier, 2003.