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

ELECTRICAL AND ELECTRONICS ENGINEERING

B.TECH. DEGREE PROGRAMME

VTR UGE 2021 CURRICULUM AND SYLLABI

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/lateral entry students in various course categories

Curriculum Component	Number of Credits	
	Regular	**Lateral Entry**
Foundation Courses (FC)	56	22
Programme Core (PC)	58	48
Programme Elective (PE)	18	18
Open Elective (OE)	12	12
Independent Learning (IL)	14	14
Industry/Higher Institute Learning Interaction (IHL)	2	2
Professional Proficiency Courses (PPC)	4	4
Total Credits	164	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	20
2	10211EE102	DC Machines & Transformers	22
3	10211EE103	AC Machines	24
4	10211EE104	Digital Electronics	26
5	10211EE105	Linear Control Systems	28
6	10211EE106	Measurements and Instrumentation	30
7	10211EE107	Transmission & Distribution	32
8	10211EE108	Power Electronics	34
9	10211EE109	Power System Analysis	36
10	10211EE110	Power System Operation & Control	38
11	10211EE112	Microprocessor & Microcontrollers	40
12	10211EE113	Electronic Circuits	42
13	10211EE114	Linear Integrated Circuits	44
14	10211EE201	Electromagnetic Fields	47
15	10211EE202	Electrical Machine Design	49
16	10211EE203	Switchgear and Protection	51
17	10211EE301	Circuits and Devices Laboratory	54
18	10211EE302	DC Machines & Transformers Laboratory	55
19	10211EE303	AC Machines Laboratory	57
20	10211EE304	Control & Instrumentation Laboratory	59
21	10211EE305	Microprocessor & Microcontrollers Laboratory	61
22	10211EE306	Analog and Digital Electronics Laboratory	63
23	10211EE307	Power Electronics Laboratory	64
24	10211EE308	Power System Simulation Laboratory	66

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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	20
2.	10211EE104	Digital Electronics	26
3.	10211EE105	Linear Control Systems	28
4.	10211EE107	Transmission and Distribution	32
5.	10211EE108	Power Electronics	34
6.	10211EE109	Power System Analysis	36
7.	10211EE110	Power System Operation and Control	38
8.	10211EE112	Microprocessor and Microcontrollers	40
9.	10211EE113	Electronic Circuits	42
10.	10211EE114	Linear Integrated Circuits	44
11.	10211EE201	Electromagnetic Fields	47
12.	10211EE202	Electrical Machine Design	49
13.	10211EE203	Switchgear and Protection	51
14.	10211EE301	Circuits and Devices Laboratory	54
15.	10211EE304	Control and Instrumentation Laboratory	59
16.	10211EE305	Microprocessor and Microcontrollers Laboratory	61
17.	10211EE306	Analog and Digital Electronics Laboratory	63
18.	10211EE307	Power Electronics Laboratory	64
19.	10211EE308	Power System Simulation Laboratory	66

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	71
2.	10212EE122	High Voltage Engineering	73
3.	10212EE123	Advances in Power System	75
4.	10212EE124	Power Plant Engineering	77
5.	10212EE125	High Voltage Direct Current Transmission	79
6.	10212EE126	Load Forecasting and Generation Forecasting	81
7.	10212EE127	Load Dispatching	83
8.	10212EE128	Reactive Power Management	85
9.	10212EE129	Smart Grid	87
Power Electronics & Drives Domain			
10.	10212EE130	LED Lighting Technology	89
11.	10212EE131	Flexible AC Transmission Systems	91
12.	10212EE132	Modern Power Converters	93
13.	10212EE133	Automotive Electrical & Electronics Systems	95
14.	10212EE134	Fundamentals of Electric and Hybrid Vehicles	97
15.	10212EE135	Special Electrical Machines	99
16.	10212EE136	Electromagnetic Interference & Compatibility	101
17.	10212EE137	Solid State Drives	103
Embedded Systems Domain			
18.	10212EE138	Principles of Robotics	105
19.	10212EE139	Embedded Systems	107
20.	10212EE140	Embedded Control of Electric Drives	109
21.	10212EE141	VLSI System & Design	111
22.	10212EE142	Wearable Electronics	113
Instrumentation & Control Domain			
23.	10212EE143	Virtual Instrumentation	115
24.	10212EE144	Digital Control Systems	117
25.	10212EE145	Introduction to Nonlinear Dynamical Systems	119
26.	10212EE146	Discrete Time Signal Processing	121

Sl No.	Course Code	Lecture Courses	Page No.
Power Systems Domain			
27.	10212EE147	Signals and Systems	123
28.	10212EE148	Soft Computing	125
29.	10212EE149	Bio Medical Instrumentation	127
30.	10212EE150	Process Automation	129
Energy Domain			
31.	10212EE151	Utilization of Electrical Energy	131
32.	10212EE152	Energy Auditing and Management	133
33.	10212EE153	Electrical Safety & Safety Management	135
34.	10212EE154	Renewable Energy Sources	137
35.	10212EE155	Solar Electric Systems	139
36.	10212EE156	Wind Energy Conversion Systems	141
37.	10212EE157	Generation Planning	143
38.	10212EE158	Solar Photovoltaic Systems	145
Electronics Domain			
39.	10212EE159	Nano Electronics	147
40.	10212EE160	Green Electronics	149
41.	10212EE161	Automotive Electronics	151
42.	10212EE162	Vehicle Electronics	153
43.	10212EE163	Optoelectronic Devices	155
44.	10212EE164	Electronic Circuit Simulation and PCB Design	157
45.	10212EE165	Medical Electronics	159
46.	10212EE166	Power Semiconductor Materials	161
47.	10212EE167	Power System Automation	163
Integrated Courses			
48.	10212EE201	Applied Soft Computing	165
49.	10212EE202	Switch Mode Power Supply Design and Development	167
50.	10212EE203	Electrical Machines	170
Laboratory Course			
51.	10212EE301	Voltage Stabilizer Fabrication	173

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	177
2.	10213EE102	Biomedical Instrumentation	179
3.	10213EE103	Introduction to Automation	181
4.	10213EE104	Virtual Instrumentation	183
5.	10213EE105	Finite Element Analysis	185
6.	10213EE106	EMI & EMC Techniques	187
7.	10213EE107	Power Supply Quality	189
8.	10213EE108	LED Lighting	191
9.	10213EE109	Transducers And Sensors	193
10.	10213EE110	Signals and Systems	195
11.	10213EE111	Wearable Electronics	197
12.	10213EE112	Embedded System	199
13.	10213EE113	Estimation For Electrical Wiring	201
14.	10213EE114	Renewable Energy Systems	203
15.	10213EE115	Automotive Electrical & Electronics Systems	205
16.	10213EE116	Hybrid Electric Vehicles	207
17.	10213EE117	Introduction to Robotics	209
18.	10213EE118	Standards, Calibration, Testing & Maintenance of Electrical Equipments	211
19.	10213EE119	Electrical Safety, Operation & Regulations	213
20.	10213EE120	Energy Conservation and Management	215
21.	10213EE121	Electrical Machines	217
22.	10213EE122	Industrial Electrical Systems	219
23.	10213EE123	Computer Aided Analysis of Electrical Apparatus	221

Sl.No	Course Code	Lecture Courses	Page No.
24.	10213EE124	Green Energy Resources	223
25.	10213EE125	Robotics and Automation	225
26.	10213EE126	Wind Energy Technology	227
27.	10213EE127	Electrical Safety and Safety Management	229
28.	10213EE130	Wind and Solar Power System	231
Integrated Courses			
29.	10213EE201	Switch Mode Power Supply design and Development	233
Laboratory Courses			
30.	10213EE301	Voltage Stabilizer Fabrication	236

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	240
2.	10212EE102	Operating Systems	242
3.	10212EE204	Object Oriented Programming using Java	244
4.	10212EE104	Data Structures and Algorithms	247
5.	10212EE105	Computer Networks and Communication	249
6.	10212EE106	Artificial Intelligence	251
7.	10212EE107	Data Base Systems and Programming	253
8.	10212EE108	Internet of Things	255
9.	10212EE109	Big Data Analytics	257
10.	10212EE110	Cloud Computing	259
11.	10212EE206	Data Structures and Algorithms using C	261

*Students shall earn 3 credits under Program Electives category thro' NPTEL/SWAYAM.

B.Tech. – EEE with Specialization in Electric Vehicles

List of Courses for 18 Credits*

Sl.No.	Course Code	Course Name	L	T	P	C	Page No.
1	10212EE111	Principles of EV Technology	3	0	0	3	267
2	10212EE112	EV Drives and Control	3	0	0	3	269
3	10212EE113	Energy Storage Systems	3	0	0	3	271
4	10212EE114	EV Charging Station	3	0	0	3	273
5	10212EE205	EV Modelling and Simulation	2	0	2	3	275
6	10212EE115	Hybrid Electric Vehicle Technologies	3	0	0	3	277
7	10212EE116	In-Vehicle Networking	3	0	0	3	279
8	10212EE117	Intelligent Vehicle Technology	3	0	0	3	281
9	10212EE118	Plug In Electric Vehicles in Smartgrid	3	0	0	3	283

*Students shall earn 3 credits under Program Electives category thro' NPTEL/SWAYAM.

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

Sl.No.	Course Code	Lecture Courses	Page No.
1.	10213EE131	Charging Station	287
2.	10213EE132	Battery Management System	289
3.	10213EE133	Electric Propulsion System and Control	291
4.	10213EE134	Hybrid Electric Vehicle Technologies	293
5.	10213EE135	Energy Storage Systems and Control	295
6.	10213EE136	Modelling and Simulation of EV	297

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

S.No.	Course Code	Lecture Courses	Page No.
1.	10213EE141	Renewable Energy	301
2.	10213EE142	Wind Energy Conversion Systems	303
3.	10213EE202	Solar Photovoltaics: Fundamentals, Technology and Applications **(Integrated)**	305
4.	10213EE144	Conversion of Energy in Buildings	308
5.	10213EE145	Solar Thermal Energy Systems	310
6.	10213EE146	Distributed Generation and Integration of Renewable Energy with Grid	312

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

Sl.No.	Course Code	Lecture Courses	Page No.
1.	10212EE171	Smart Grid	316
2.	10212EE172	Energy Management and SCADA	318
3.	10212EE173	Power System Restructuring	320
4.	10212EE174	Distributed Generation and Micro Grid	322
5.	10212EE175	IoT Applications in Smart Grid	324
6.	10212EE176	AI for Smart Grid Systems	326



VTR UGE 2021 Regulations - Curriculum
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.	10211EE112	Microprocessor and Microcontrollers	3	0	0	3
12.	10211EE113	Electronic Circuits	3	0	0	3
13.	10211EE114	Linear Integrated Circuits	3	0	0	3
INTEGRATED COURSES						
14.	10211EE201	Electromagnetic Fields	2	0	2	3
15.	10211EE202	Electrical Machine Design	2	1	2	4
16.	10211EE203	Switchgear and Protection	2	0	2	3
LABORATORY COURSES						
17.	10211EE301	Circuits and Devices Laboratory	0	0	2	1
18.	10211EE302	DC Machines and Transformers Laboratory	0	0	2	1
19.	10211EE303	AC Machines Laboratory	0	0	2	1
20.	10211EE304	Control and Instrumentation Laboratory	0	0	2	1
21.	10211EE305	Microprocessor and Microcontrollers Laboratory	0	0	2	1
22.	10211EE306	Analog and Digital Electronics Laboratory	0	0	2	1
23.	10211EE307	Power Electronics Laboratory	0	0	2	1
24.	10211EE308	Power System Simulation Laboratory	0	0	2	1
		TOTAL				**58**

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VTR UGE 2021 Regulations - 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.	10211EE112	Microprocessor and Microcontrollers	3	0	0	3
9.	10211EE113	Electronic Circuits	3	0	0	3
10.	10211EE114	Linear Integrated Circuits	3	0	0	3
INTEGRATED COURSES						
11.	10211EE201	Electromagnetic Fields	2	0	2	3
12.	10211EE202	Electrical Machine Design	2	1	2	4
13.	10211EE203	Switchgear and Protection	2	0	2	3
LABORATORY COURSES						
14.	10211EE301	Circuits and Devices Laboratory	0	0	2	1
15.	10211EE304	Control and Instrumentation Laboratory	0	0	2	1
16.	10211EE305	Microprocessor and Microcontrollers Laboratory	0	0	2	1
17.	10211EE306	Analog and Digital Electronics Laboratory	0	0	2	1
18.	10211EE307	Power Electronics Laboratory	0	0	2	1
19.	10211EE308	Power System Simulation Laboratory	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: Nil

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	Apply Kirchhoff's laws, mesh current and nodal voltage methods to analyze DC and AC circuits.	K3
CO2	Apply network theorems to determine circuit responses in DC and AC networks.	K3
CO3	Construct network graphs and determine network matrices and two-port network parameters.	K3
CO4	Analyze magnetically coupled circuits and balanced and unbalanced three-phase circuits.	K4
CO5	Analyze transient responses of RL, RC and RLC circuits and determine resonance characteristics, quality factor and bandwidth.	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										L	H	
CO2	H	H										L	H	
CO3	H	H	M									L	H	M
CO4	H	H										L	H	M
CO5	H	H		M								L	H	M

COURSE CONTENTS:		
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

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	Explain 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	Explain the equivalent circuit of transformers and the testing methods used to determine their performance characteristics.	K2
CO5	Explain three-phase transformer connections and the conditions for 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	M										L	M	L
CO2	H	H		M								L	H	M
CO3	H	H		M								L	H	M
CO4	H	H		H								L	H	M
CO5	H	H	L	M								L	H	M

COURSE CONTENTS:		
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

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

COURSE CONTENTS:		
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: Nil

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	Explain the fundamental concepts of digital electronics, number systems and Boolean algebra.	K2
CO2	Design combinational logic circuits from given Boolean expressions using suitable minimization techniques.	K4
CO3	Explain the operating principles and functional characteristics of flip-flops, registers and counters.	K2
CO4	Design synchronous and asynchronous sequential circuits using state tables, state diagrams and suitable design models.	K4
CO5	Explain the applications of digital electronics in measurement, data conversion and programmable logic devices.	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	M
CO2	H	H	M									L	H	M
CO3	H	H	L									L	H	M
CO4	H	H	H	M								L	H	H
CO5	M	M	L	M								L	M	M

COURSE CONTENTS:		
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: Nil

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 models and determine transfer functions of electrical, mechanical, and electromechanical systems using block diagram reduction and signal flow graph methods.	K3
CO2	Explain the time-domain specifications of control systems and their significance in system performance evaluation.	K2
CO3	Analyze control-system performance using frequency-response plots and root locus.	K4
CO4	Analyze system stability and relative stability using time-domain and frequency-domain techniques.	K4
CO5	Select suitable compensators based on specified performance requirements and explain the operation of P, PI, and PID controllers.	K3
CO6	Develop state-space models from transfer functions and obtain transfer functions from state-space representations.	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	H	M
CO2	H	M										L	H	M
CO3	H	H	M	M	M							L	H	M
CO4	H	H	M	M	M							L	H	M
CO5	H	H	M		M							L	H	H
CO6	H	H	M		M							L	H	M

COURSE CONTENTS:		
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

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 measurement standards, calibration procedures, measurement errors, and instrument characteristics.	K2
CO2	Explain the operating principles and types of electrical and electronic measuring instruments.	K2
CO3	Explain the operating principles and applications of DC and AC bridges for electrical measurements.	K2
CO4	Explain the principles and characteristics of storage and display devices used in measurement systems.	K2
CO5	Explain the types, operating principles, and applications of transducers used for measurement and 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	M		M								L	H	L
CO2	H											L	H	M
CO3	H	M		M								L	H	M
CO4	H											L	H	L
CO5	H			M								L	H	M

COURSE CONTENTS:		
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: Nil

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	Calculate the resistance, inductance, and capacitance of single- and three-phase transmission lines under different conductor and spacing configurations.	K3
CO2	Develop equivalent circuit models of short, medium, and long transmission lines and calculate voltage regulation and transmission efficiency.	K3
CO3	Calculate the performance parameters of overhead lines and insulators, including sag, string efficiency, and corona characteristics.	K3
CO4	Explain the construction, classification, and electrical characteristics of underground cables.	K2
CO5	Analyze DC and AC distributors and calculate their voltage and current distribution under specified loading conditions.	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										L	H	M
CO2	H	H	M	M								L	H	M
CO3	H	H	M	M								L	H	M
CO4	H	M										L	H	L
CO5	H	H	M	M								L	H	M

COURSE CONTENTS:		
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: Electronic Circuits

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	Analyze the operation and performance of single-phase and three-phase controlled rectifiers with different load conditions.	K4
CO3	Analyze the operating principles and performance of DC–DC choppers and switching regulators under different operating conditions.	K4
CO4	Analyze PWM inverter operation and evaluate techniques for voltage control and harmonic reduction.	K4
CO5	Select suitable AC voltage controllers and cycloconverters for specified applications based on their operating characteristics.	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
CO2	H	H	M	M	M							L	H	M
CO3	H	H	M	M	M							L	H	M
CO4	H	H	M	M	M							L	H	H
CO5	H	H	M	M	M							L	H	M

COURSE CONTENTS:		
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: Nil

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 operating principles and per-unit modelling of power system components.	K2
CO2	Apply load-flow solution methods to determine bus voltage magnitudes, phase angles and power flows in a power system.	K3
CO3	Calculate symmetrical three-phase fault currents and short-circuit capacity using power system network models.	K3
CO4	Analyze unsymmetrical faults using symmetrical components, sequence networks and bus impedance matrices.	K4
CO5	Analyze transient stability of power systems under disturbances using the swing equation, equal-area criterion and numerical integration methods.	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	M											H	L
CO2	H	H		M	M						L	L	H	L
CO3	H	H	M	M	M						L	L	H	L
CO4	H	H	M	M	M						L	L	H	L
CO5	H	M	M	M	M							L	H	L

COURSE CONTENTS:		
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

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	Explain the need for frequency and voltage regulation and the real-time control structure of modern power systems.	K2
CO2	Apply load-forecasting and unit-commitment methods to estimate base load and schedule generating units subject to operating constraints.	K3
CO3	Analyze plant-level and system-level real-power control, including single-area and two-area load-frequency control.	K4
CO4	Solve economic dispatch problems with and without transmission losses and analyze the integration of economic dispatch with 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	M											H	M
CO2	H	H			M								H	M
CO3	H	H		M									H	L
CO4	H	H		M	M								H	L
CO5	H	H	M	M									H	L

COURSE CONTENTS:		
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:	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: Nil

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 8085 assembly language programs using the instruction set and addressing modes to meet specified requirements.	K3
CO2	Explain the functions and operating principles of 8085 peripheral devices.	K2
CO3	Explain the architecture, memory organization and functional blocks of the 8051 microcontroller.	K2
CO4	Develop 8051 assembly language and Embedded C programs using timers, interrupts, serial communication and interfacing features to meet specified requirements.	K3
CO5	Explain the architectures and application areas of PIC, ARM and ATmega microcontrollers in embedded 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	H	M	L									H	H
CO2	H	M											H	M
CO3	H	M											H	M
CO4	H	H	H	M									H	H
CO5	H	M											M	M

COURSE CONTENTS:		
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: Nil

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	Explain the operating principles of BJT and FET amplifiers and oscillator circuits	K2
CO2	Explain the operating principles of transistorized amplifier and oscillator circuits.	K2
CO3	Explain the concept and topologies of feedback amplifiers	K2
CO4	Describe 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	M										L	H	M
CO2	H	M										L	H	M
CO3	H	M										L	H	M
CO4	H	M										L	H	M
CO5	H	H	M	M								L	H	M

COURSE CONTENTS:		
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: Electronic Circuits

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	H	L	L								H	H
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 CONTENTS:		
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

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: Nil

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 the fundamental concepts of electrostatics, vector fields, and the laws governing electric fields.	K2
CO2	Apply electrostatic field principles to analyze electric fields and dielectric materials.	K3
CO3	Explain the fundamental concepts of magnetostatics and the laws governing magnetic fields.	K2
CO4	Apply field equations and numerical tools to determine electric and magnetic field distributions using FEM/FDM packages.	K3
CO5	Analyze electromagnetic wave propagation in free space, dielectrics, and conductors, including wave parameters and skin depth.	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	M						L	L	L			H	
CO2	H	H						L	L	L			H	
CO3	H	M						L	L	L			H	
CO4	H	H		M	H			L	L	L			H	
CO5	H	H		M	L			L	L	L			H	

COURSE CONTENTS:		
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, Utilization factor – Electric field in free space, conductors, dielectrics - Dielectric polarization – Dielectric strength – Boundary conditions, Poisson's and Laplace's equations - Applications.		
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 - Magnetic flux density (B) – B in free space, conductor - magnetic materials – Magnetization– Boundary conditions - Poisson's Equation - Applications		
UNIT IV	**ELECTRODYNAMIC FIELDS AND SOLUTION OF FIELD EQUATIONS (FEM)**	**6**
Magnetic Circuits - Faraday's law – Transformer and motional EMF – Displacement current -Maxwell's equations (differential and integral form) – Relation between field theory and circuit theory – Applications.		
UNIT V	**ELECTROMAGNETIC WAVES**	**6**
Electromagnetic wave generation and equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossy and lossless dielectrics, conductors - skin depth - Poynting vector, Application		
		TOTAL: 30 PERIODS

LIST OF EXPERIMENTS (30 PERIODS)

1. Plotting of vectors using mathematical development tool
2. Computation and plotting of curl fields using mathematical development tool
3. Computation and plotting of gradient and divergence fields using mathematical development tool
4. Coulombs law with two charged objects
5. Electromagnetic Induction
6. Charged particle in magnetic field
7. Study of Force acting on the conductor in DC motor
8. Computation of electric field intensity, voltage distribution and capacitance using FEM/FDM packages
9. Computation of magnetic field intensity, inductance and force using FEM/FDM packages
10. Calculation of skin depth using FEM/FDM packages

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

COURSE CODE:10211EE202	COURSE TITLE: ELECTRICAL MACHINE DESIGN	L	T	P	C
		2	1	2	4

COURSE CATEGORY: Program Core (Integrated)

PREAMBLE: This course 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

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 design concept of armature and field winding of DC machine
- Understand of basic design and cooling system of electrical transformer
- Understand the design concept of induction machine
- Understand the design 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	Calculate the MMF required for different types of electrical machines.	K2
CO2	Apply design principles to determine the dimensions of DC machine armature, field system, commutator, and brushes.	K3
CO3	Apply design principles to determine transformer core, winding, tank, and cooling dimensions.	K3
CO4	Apply design principles to determine the dimensions and parameters of the stator and rotor of induction machines.	K3
CO5	Select appropriate design parameters for the stator and rotor of 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	H	M		M	M			L	L	L		L	H	M
CO2	H	M	M		M			L	L	L		L	H	M
CO3	H	M	M	M	M	M	M	L	L	L		L	H	M
CO4	H	H	H	M	H		M	L	L	L		L	H	H
CO5	H	H	H	M	H		M	L	L	L		L	H	H

COURSE CONTENTS:		
UNIT I	**MMF CALCULATIONS FOR ROTATING ELECTRICAL MACHINES**	**9**
Major considerations in electrical machine design – Design of magnetic circuits – MMF for air gap-MMF for teeth - Real and apparent flux densities–leakage flux		
UNIT II	**DESIGN OF D.C MACHINES**	**9**
Output equation - Choice of poles - Design of field system - Design of armature - Design of commutator and brush		
UNIT III	**DESIGN OF TRANSFORMERS**	**9**
Output equation of single phase and three phase Transformer, Design of core, design of winding - Design of tank and cooling tubes		
UNIT IV	**DESIGN OF INDUCTION MACHINES**	**9**
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**	**9**
Output equations - Runaway speed - Short Circuit Ratio- Design of salient pole machine - Armature design - Estimation of air gap length - Design of damper winding - Design of field winding – Design of turbo alternator		
		TOTAL (L): 45 PERIODS

List of Experiments (30 PERIODS)

1. Design and simulation of DC machine to obtain the electrical and mechanical characteristics.
2. Design and calculation of core losses and copper losses for shell type transformer.
3. Design and fabrication of single phase step down transformer.
4. Design and calculation of magnetic loading for 3-phase induction motor.
5. Design and simulation of 3-phase induction motor to obtain torque-slip characteristics.
6. Design and simulation of PMSM to find torque-speed characteristics.
7. Design and simulation of synchronous generator to obtain output power characteristics.

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

COURSE CODE: 10211EE203	COURSE TITLE: SWITCHGEAR AND PROTECTION	L	T	P	C
		2	0	2	3

COURSE CATEGORY: Program Core (Integrated)

PREAMBLE: The functioning of a power system depends significantly on efficient and reliable protection schemes. This course provides the fundamentals of power system protection and switchgear technology including relay & breaker principles, types, operations and applications.

PREREQUISITE 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	Explain the essential qualities of a protective system and the fundamental protection terminologies	K2
CO2	Compare the operating principles of relays based on their technology and functional requirements	K2
CO3	Explain protection schemes used for generators, transformers, busbars, feeders, motors, and transmission lines.	K2
CO4	Compare the operating principles and characteristics of different types of circuit breakers	K2
CO5	Explain the operating principles, functional blocks, and algorithms used in digital protection schemes.	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	L			H	L
CO2	H	M		M	M			L	L	L			H	M
CO3	H	M		M	M			L	L	L			H	M
CO4	H	M		M	M			L	L	L			H	L
CO5	H	M		M	M			L	L	L			H	M

COURSE CONTENTS:		
UNIT I	**INTRODUCTION**	**4**
Basic terminology - essential qualities of a protective relay - The universal relay - torque equation, RX diagram - CT, PT & applications		
UNIT II	**ELECTROMAGNETIC RELAYS**	**7**
Electromagnetic relays–operating principles of relays-Over current relays –directional over current relays - distance relays,- differential relays - under frequency and negative sequence relays		
UNIT III	**CIRCUIT BREAKERS**	**7**
Arcing phenomena and arc quenching - circuit breaker rating– RRRV - Current Chopping and Capacitive current breaking-DC circuit breaking- Oil minimum circuit breakers - Air blast circuit breakers - Vacuum and SF6 circuit breakers		
UNIT IV	**PROTECTION OF POWER APPARATUS**	**6**
Generator protection - Transformer protection – Bus bar protection - Feeder protection - A.C. Motor protection and carrier current protection of transmission lines, Relay coordination study.		
UNIT V	**DIGITAL PROTECTION**	**6**
Introduction, Advantages of digital protection, Basic elements of digital protection, Operation of digital relay, Mathematical background to digital algorithms: Sinusoidal-wave based algorithm and Walsh function, Digital overcurrent protection		
		TOTAL (L): 30 PERIODS

List of Experiments (30 PERIODS)

1. Time-current characteristics of electromechanical over current/earth fault relay.
2. Time-voltage characteristics of electromechanical under voltage relay.
3. Time-voltage characteristics of electromechanical over voltage relay.
4. Simulation of differential protection.
5. Simulation of distance protection.

TEXT BOOKS:

1. Badri Ram and Viswakarma, D.N., “Power System Protection and Switch Gear”, Tata McGraw-Hill Publishing Company Ltd., 2001.
2. Bhavesh Bhalja, R. P. Maheshwari, N. G. Chothani, “Protection and Switchgear”, Oxford University Press, 2nd edition, New Delhi, India, 2018.

REFERENCE BOOKS:

1. B.Ravindranath and N.Chander, "Power Systems protection and switchgear", Wiley Eastern Ltd, 1977.
2. C.L.Wadhwa, "Electric power systems", New Age International (P) Ltd publishers, 1983.
3. Sunil S. Rao, "Switchgear and protection", Khanna publishers, New Delhi, 1986.
4. T.S.Madhava Rao, “Power System Protection Static Relays”, Second Edition, Tata McGraw Hill, 2004
5. https://onlinecourses.nptel.ac.in/noc21_ee110/preview

LABORATORY COURSES

COURSE CODE:	COURSE TITLE:	L	T	P	C
10211EE301	**CIRCUITS AND DEVICES LABORATORY**	**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: Nil

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	Verify network theorems experimentally and validate the results.	K3, S2
CO2	Determine the parameters of two-port networks.	K3, S2
CO3	Measure electrical power in electrical circuits using appropriate instruments.	K3, S2
CO4	Determine the V–I characteristics of PN junction diodes and BJT transistors experimentally.	K3, S2
CO5	Determine the V–I characteristics of UJT, JFET, and MOSFET devices experimentally.	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	M	H		H	M			L		L			H	L
CO2	M	H		H	M			L		L			H	M
CO3	M	H		H	M			L		L			H	M
CO4	M	H		H	M			L		L			H	M
CO5	M	H		H	M			L		L			H	M

LIST OF EXPERIMENTS:

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.
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 AND TRANSFORMERS LABORATORY**	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: Nil

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	Apply DC generator principles to obtain and analyze the open-circuit and load characteristics of separately excited and self-excited DC shunt generators.	K3, S3
CO2	Apply the principles of compounding to obtain the load characteristics of DC compound generators and motors under cumulative and differential connections.	K3, S3
CO3	Determine the load characteristics of DC shunt and series motors by applying appropriate experimental procedures and measurement techniques.	K3, S3
CO4	Analyze the performance of DC shunt motor speed-control methods and the efficiency of DC machines using Swinburne's test.	K4, S3
CO5	Apply open-circuit, short-circuit, and load testing procedures to calculate the performance parameters of single-phase and three-phase 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	M	H		H	H			L		L			H	M
CO2	M	H		H	H			L		L			H	M
CO3	M	H		H	H			L		L			H	M
CO4	M	H		H	H			L		L			H	M
CO5	M	H		H	H			L		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 single phase Transformer
11. Study of DC Motor Starters

COURSE CODE: **10211EE303**	COURSE TITLE: **AC MACHINES LABORATORY**	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: Nil

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	Determine the voltage regulation of three-phase alternators using EMF, MMF, and ZPF methods and the synchronous machine parameters using the slip test.	K3, S2
CO2	Analyze the V and inverted-V curves of synchronous motors to assess the effect of field excitation on armature current and power factor.	K4, S2
CO3	Analyze the performance characteristics of three-phase induction motors using the circle diagram.	K4, S2
CO4	Calculate the equivalent circuit parameters of three-phase induction motors using no-load and blocked-rotor test results.	K4, S2
CO5	Apply speed-control methods to slip-ring induction motors to obtain the desired operating speed.	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		H	M			L		L			H	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	H

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: **10211EE304**	COURSE TITLE: **CONTROL AND INSTRUMENTATION LABORATORY**	L	T	P	C
		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: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Measure displacement, resistance, inductance, torque, and angle.
- Gain exposure to AC and DC bridge measurements.
- Design compensators.
- Determine the transfer functions 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	Determine the transfer functions of electrical machines experimentally.	K3, S3
CO2	Design first-order and second-order compensators based on given specifications.	K3, S2
CO3	Measure the phase difference, voltage, current, and frequency of an input signal using appropriate instruments.	K3, S2
CO4	Determine circuit parameters using DC and AC bridges.	K3, S2
CO5	Obtain the B–H curve of a magnetic material using a solenoid setup.	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		H	H			L		L			H	M
CO2	H	M		H	M			L		L			H	M
CO3	H	H		H	H			L		L			H	M
CO4	H	H		H	H			L		L			H	M
CO5	H	H		H	H			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: **10211EE305**	COURSE TITLE: **MICROPROCESSOR AND MICROCONTROLLERS LABORATORY**	**L**	**T**	**P**	**C**
		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: Nil

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	Develop assembly language programs for arithmetic operations and code conversions using the 8085 microprocessor.	K3, S3
CO2	Interface USART, ADC/DAC, timer, and keyboard/display controllers with the 8085 microprocessor.	K3, S3
CO3	Develop assembly language programs for arithmetic operations, timers/counters, and interrupt handling using the 8051 microcontroller.	K3, S3
CO4	Interface stepper motors, DC motors, ADC/DAC, keyboards, and LCDs with the 8051 microcontroller.	K3, S3
CO5	Develop assembly language programs for arithmetic operations and code conversions using the 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	H	M	M	M			L		L			H	M
CO2	H	H	M	H	M			L		L			H	H
CO3	H	H	M	M	M			L		L			H	M
CO4	H	H	H	H	M			L		L			H	H
CO5	M	M	M	M	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: 10211EE306	COURSE TITLE: ANALOG AND DIGITAL ELECTRONICS LABORATORY	L	T	P	C
		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: 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	Analyze the performance of amplifier circuits.	K4,S3
CO2	Design and implement oscillator circuits.	K3,S3
CO3	Identify different logic gates and their functions.	K2,S1
CO4	Construct combinational circuits using logic gates.	K3,S3
CO5	Design and implement counter circuits.	K3,S3

CORRELATION OF COs WITH POs AND PSOs

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

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 and interpret the characteristics of various power switching devices.	K2, S2
CO2	Demonstrate the operation of single-phase and three-phase rectifiers.	K2, S3
CO3	Implement power and control circuits for single-phase half-bridge and full-bridge inverters and three-phase inverters.	K3, S3
CO4	Implement DC–DC converters with appropriate control techniques.	K3, S3
CO5	Demonstrate the operation 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		H	H			L		L			H	M
CO2	H	H		H	H			L		L			H	M
CO3	H	H	M	H	H			L		L			H	H
CO4	H	H	M	H	H			L		L			H	H
CO5	H	H	M	H	H			L		L			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.

COURSE CODE: **10211EE308**	COURSE TITLE: **POWER SYSTEM SIMULATION LABORATORY**	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: Nil

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	Calculate transmission-line parameters and evaluate line performance	K3, S2
CO2	Formulate Ybus and Zbus matrices and perform load-flow analysis using numerical methods.	K3, S2
CO3	Perform and analyse short-circuit studies using network and symmetrical-component analysers.	K3, S3
CO4	Simulate and evaluate single-area and two-area load-frequency control systems	K3, S2
CO5	Analyze the transient stability of power systems.	K4, S3
CO6	Determine the economic dispatch schedule of generating units.	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	H			L		L		L	H	M
CO2	H	H	M	H	H			L		L		L	H	H
CO3	H	H	M	H	H			L		L		L	H	H
CO4	H	H	M	H	H			L		L		L	H	H
CO5	H	H	M	H	H			L		L			H	H
CO6	H	H	M	H	H			L		L			H	H

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						
10.	10212EE130	Led Lighting Technology	3	0	0	3
11.	10212EE131	Flexible AC Transmission Systems	3	0	0	3
12.	10212EE132	Modern Power Converters	3	0	0	3
13.	10212EE133	Automotive Electrical and Electronics Systems	3	0	0	3
14.	10212EE134	Fundamentals of Electric and Hybrid Vehicles	3	0	0	3
15.	10212EE135	Special Electrical Machines	3	0	0	3
16.	10212EE136	Electromagnetic Interference and Compatibility	3	0	0	3
17.	10212EE137	Solid State Drives	3	0	0	3
EMBEDDED SYSTEMS DOMAIN						
18.	10212EE138	Principles of Robotics	3	0	0	3
19.	10212EE139	Embedded Systems	3	0	0	3
20.	10212EE140	Embedded Control of Electric Drives	3	0	0	3
21.	10212EE141	VLSI System and Design	3	0	0	3
22.	10212EE142	Wearable Electronics	3	0	0	3
INSTRUMENTATION & CONTROL DOMAIN						
23.	10212EE143	Virtual Instrumentation	3	0	0	3
24.	10212EE144	Digital Control Systems	3	0	0	3
25.	10212EE145	Introduction to Nonlinear Dynamical Systems	3	0	0	3
26.	10212EE146	Discrete Time Signal Processing	3	0	0	3
27.	10212EE147	Signals and Systems	3	0	0	3
28.	10212EE148	Soft Computing	3	0	0	3

S.NO.	COURSE CODE	COURSE NAME	L	T	P	C
29.	10212EE149	Bio Medical Instrumentation	3	0	0	3
30.	10212EE150	Process Automation	3	0	0	3
ENERGY DOMAIN						
31.	10212EE151	Utilization of Electrical Energy	3	0	0	3
32.	10212EE152	Energy Auditing and Management	3	0	0	3
33.	10212EE153	Electrical Safety and Safety Management	3	0	0	3
34.	10212EE154	Renewable Energy Sources	3	0	0	3
35.	10212EE155	Solar Electric Systems	3	0	0	3
36.	10212EE156	Wind Energy Conversion Systems	3	0	0	3
37.	10212EE157	Generation Planning	3	0	0	3
38.	10212EE158	Solar Photovoltaic Systems	3	0	0	3
ELECTRONICS DOMAIN						
39.	10212EE159	Nano Electronics	3	0	0	3
40.	10212EE160	Green Electronics	3	0	0	3
41.	10212EE161	Automotive Electronics	3	0	0	3
42.	10212EE162	Vehicle Electronics	3	0	0	3
43.	10212EE163	Optoelectronic devices	3	0	0	3
44.	10212EE164	Electronic Circuit Simulation and PCB Design	3	0	0	3
45.	10212EE165	Medical Electronics	3	0	0	3
46.	10212EE166	Power Semiconductor Materials	3	0	0	3
47.	10212EE167	Power System Automation	3	0	0	3
INTEGRATED COURSES						
48.	10212EE201	Applied Soft Computing	2	0	2	3
49.	10212EE202	Switch Mode Power Supply Design and Development	2	0	2	3
50.	10212EE203	Electrical Machines	2	0	2	3
LABORATORY COURSE						
51.	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: Nil

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 power quality issues in electrical power systems.	K2
CO2	Describe voltage sags and interruptions in power systems.	K2
CO3	Explain overvoltages and their causes in power systems.	K2
CO4	Explain harmonic distortion and methods for its control.	K2
CO5	Illustrate the fundamentals of power quality monitoring and the operation of monitoring equipment.	K2

CORRELATION OF COs AND POs

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

COURSE CONTENTS:		
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: Nil

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)
CO1	Explain the principles of generating high DC, AC, and impulse voltages.	K2
CO2	Develop equivalent circuit models of different high-voltage generators.	K3
CO3	Analyze the dynamic response of high-voltage measurement systems.	K4
CO4	Explain the breakdown strength of gas-filled insulation systems with simple geometries.	K2
CO5	Explain the principles, applications, and hazards of electrostatic charges in high-voltage 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									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 CONTENTS:		
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 fundamentals of harmonics and subharmonic oscillations in power systems.	K2
CO2	Explain the stability concepts and analysis of multimachine power systems.	K2
CO3	Describe power quality standards, power quality curves, and monitoring devices.	K2
CO4	Explain the fundamentals of grid and distribution systems.	K2
CO5	Summarize power system networking, protection, and control concepts.	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 CONTENTS:		
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: Nil

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 the working principles of thermal power plants.	K2
CO2	Describe the features and operation of hydroelectric power plants.	K2
CO3	Explain the working principles of nuclear power plants.	K2
CO4	Explain the working principles of gas turbine and diesel power plants.	K2
CO5	Summarize the operating principles of renewable energy 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	H	
CO2	H					L	M					L	H	
CO3	H					L						L	H	
CO4	H					L						L	H	
CO5	H					M	H					M	H	

COURSE CONTENTS:

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: Nil

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 the fundamentals of HVDC transmission and the planning of HVDC power transmission systems.	K2
CO2	Describe the operating characteristics of HVDC converters.	K2
CO3	Explain the configuration and operation of multi-terminal HVDC (MTDC) systems and the characteristics of DC circuit breakers.	K2
CO4	Explain the effects of reactive power and harmonics in HVDC systems.	K2
CO5	Explain the characteristics of HVDC cables and the 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 CONTENTS:		
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 methods of load forecasting.	K2
CO2	Summarize the fundamental concepts of energy management.	K2
CO3	Illustrate energy demand forecasting methods and their applications.	K2
CO4	Explain energy management strategies and case studies related to energy forecasting.	K2
CO5	Describe generation planning based on load 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 CONTENTS:		
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	Explain the fundamentals of integrated power systems.	K2
CO2	Explain the functions and locations of load dispatch centres.	K2
CO3	Illustrate the equipment and general arrangement of the control room in load dispatch centres.	K2
CO4	Describe the role of telecommunication systems in power system operation.	K2
CO5	Explain the role of operating reserves in power system contingencies and their 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 CONTENTS:		
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: Nil

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	Explain the importance of reactive power and voltage control in power systems.	K2
CO2	Explain the effects of reactive power on power generation and transmission systems.	K2
CO3	Explain the effects of reactive power in HVDC transmission systems.	K2
CO4	Explain the importance and applications of Flexible AC Transmission Systems (FACTS) devices.	K2
CO5	Describe the effects 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 CONTENTS:		
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: Program Elective

PREAMBLE: To enable the students to understand the requirement of smart grid, acquire knowledge of architecture, automation, advanced metering Infrastructure, distributed generation and integration, demand management, energy storage, electric vehicle and cyber security etc.,

PREREQUISITE COURSES: Nil

COURSEEDUCATIONALOBJECTIVES:

The objectives of the course are to,

- Understand the requirements of smart grid, components and architecture of smart grid.
- Educate the importance of sensors, measurement and control methods
- Familiar about the renewable energy generation and integration.
- Understand the various aspects of communications, standards and security.
- Brief about the integration of renewable energy resources and future of smart grid

COURSEOUTCOMES:

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	Compare conventional grids and smart grids.	K2
CO2	Describe the measurement methods, sensors, control, and automation technologies used in smart grids.	K2
CO3	Explain the roles of distributed generation resources and energy storage technologies in smart grids.	K2
CO4	Explain the importance of communication systems, standards, and security in smart grids.	K2
CO5	Summarize the applications of smart grids.	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	
CO2	M				M								M	
CO3	M				M		M						M	M
CO4	M				M								M	
CO5	M				M		M						M	M

COURSE CONTENTS:		
UNIT I	**INTRODUCTION**	**9**
Overview, today's grid versus smart grid, rationale for smart grid, power system enhancement, communication and standards, environment and economics, shareholders roles and function, architecture, functions of components		
UNIT II	**SENSING, MEASUREMENT, CONTROL AND AUTOMATION**	**9**
Smart meters, protocols, AMI, demand side integration, substation automation, distribution management, micro grid and smart grid comparison, wide area monitoring systems, IEDs and SCADA, Phasor measurement units, GIS and Google mapping tools, Multi agent technology		
UNIT III	**DISTRIBUTED GENERATION AND STORAGE**	**9**
Introduction, photovoltaic systems, wind, hydro and tidal energy, geothermal energy systems, Biomass, Integration, energy storage technologies: batteries, flow batteries, fuel cell, hydrogen electrolyser, flywheels, super conducting magnetic energy storage systems, super capacitors, electric vehicles, case studies		
UNIT IV	**COMMUNICATIONS, STANDARDS AND SECURITY**	**9**
Architecture of communication system, wired and wireless communication, spectrum technologies, WiMAX, Satellite Communication. interoperability and interchangeability, standards of security and safety, priority areas for standardization: consumer energy efficiency, electric transportation, smart grid cyber security		
UNIT V	**APPLICATIONS**	**9**
Demand side management, load management, energy management and conservation, smart grid analytics, demonstrations: solar/wind power generation, battery management system, smart meters, ev charging systems, IoT applications, design and analysis of smart grid : case study		
		TOTAL:45 PERIODS

TEXTBOOKS:

1. James Momoh, "Smart Grid: Fundamentals of Design and Analysis", John Wiley & Sons Inc, IEEE press, 2012.
2. Janaka Ekanayake, "Smart Grid: Technology and Applications", John Wiley & Sons Inc, 2012.

REFERENCEBOOKS:

1. Takuro Sato, Smart Grid Standards Specifications, Requirements and Technologies, First Edition, John Wiley & Sons Singapore Pte. Ltd, 2015.
2. Stuart Borlase , Smart Grids - Advanced Technologies and Solutions , Second Edition, Taylor & Francis Group, CRC Press, 2018.
3. Salman K. Salman, Introduction to the Smart Grid Concepts, Technologies and Evolution, The Institution of Engineering and Technology, 2017.
4. Qi Huang, Shi Jing "Innovative Testing and Measurement Solutions for Smart Grid", John Wiley & Sons Inc, 2015.
5. https://archive.nptel.ac.in/courses/108/107/108107113/

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: Nil

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 the principles of optical design.	K2
CO2	Explain LED lighting technologies and the different types of lighting systems.	K2
CO3	Identify the constructional features, components, and operating principles of illumination systems.	K2
CO4	Design power electronic circuits used in LED lighting systems.	K3
CO5	Develop lighting control strategies and building lighting control systems, and design and fabricate PCBs for LED lighting systems, including their repair and maintenance.	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 CONTENTS:		
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: Nil

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 fundamental concepts and operating principles of FACTS controllers.	K2
CO2	Summarize the operating principles and applications of Static VAR Compensators (SVCs).	K2
CO3	Explain the modelling, operation, and control strategies of static series compensation and Static VAR Compensators (SVCs).	K2
CO4	Explain the operating principles of voltage-source converter-based FACTS controllers.	K2
CO5	Explain the modelling and design of coordinated 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 CONTENTS:		
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 operation of single-phase thyristor-controlled converters with different types of loads.	K2
CO2	Describe the operation, characteristics, and performance parameters of three-phase thyristor-controlled converters.	K2
CO3	Explain the operating principles and characteristics of different types of DC–DC converters	K2
CO4	Explain the operation of single-phase bidirectional AC voltage controllers with R, L, and R–L loads, and three-phase AC voltage controllers.	K2
CO5	Describe the operating principles 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 CONTENTS:		
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: Nil

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)
CO1	Explain the basic architecture of automotive electrical systems.	K2
CO2	Illustrate the challenges associated with electric drives used in vehicles.	K2
CO3	Explain the arrangement and functions of sensors used in vehicles.	K2
CO4	Explain the control strategies used in automotive systems.	K2
CO5	Outline the parameters controlled by an 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 CONTENTS:		
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: Nil

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)
CO1	Explain the principles of vehicle propulsion and braking.	K2
CO2	Explain the operating principles and performance characteristics of electric vehicles (EVs).	K2
CO3	Illustrate the working principles of hybrid electric vehicles (HEVs).	K2
CO4	Explain the braking systems used in electric vehicles (EVs), hybrid electric vehicles (HEVs), and fuel cell vehicles (FCVs).	K2
CO5	Explain the environmental impacts of electric and hybrid vehicles.	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 CONTENTS:		
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: Nil

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, operating principles, and performance characteristics of synchronous reluctance motors.	K2
CO2	Explain the control schemes used for stepper motors.	K2
CO3	Summarize the performance characteristics and control methods of switched reluctance motors.	K2
CO4	Illustrate the operating principles and control methods of permanent magnet brushless DC (BLDC) motors.	K2
CO5	Interpret the operating characteristics of permanent magnet synchronous motors (PMSMs).	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 CONTENTS:		
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: Nil

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 electromagnetic compatibility (EMC) regulations and methods for eliminating electromagnetic interference.	K2
CO2	Explain the methods of grounding cable shields.	K2
CO3	Describe the principles and applications of filtering and shielding in EMC.	K2
CO4	Classify the different types of noise in digital circuits.	K2
CO5	Illustrate the principles of electrostatic discharge (ESD) and the relevant 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 CONTENTS:		
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: Nil

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 fundamental concepts of AC and DC drive systems.	K2
CO2	Illustrate the operation of converter-fed and chopper-fed DC drives and solve related numerical problems.	K3
CO3	Explain the operating principles of classical and modern induction motor drives.	K2
CO4	Interpret the operating principles and characteristics of synchronous motor drives.	K2
CO5	Explain the operating principles and applications of special electrical machine 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	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 CONTENTS:		
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: Nil

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 their sensors.	K2
CO2	Explain the fundamentals of robotic motion control and analysis.	K2
CO3	Illustrate the fundamental concepts of artificial intelligence.	K2
CO4	Develop basic programs for robotic applications.	K3
CO5	Summarize the applications of robots in various 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	M	L									M	H	
CO3	H		L									M	H	L
CO4	H	M	L									M	H	M
CO5	H		L										H	

COURSE CONTENTS:		
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 embedded systems.	K2
CO2	Describe the processor architectures and memory organization of embedded systems.	K2
CO3	Develop interfacing and communication techniques for embedded systems.	K3
CO4	Explain the input/output (I/O) mechanisms, testing methods, and applications of embedded systems.	K2
CO5	Describe the characteristics and issues of real-time systems and develop algorithms for real-time 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		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 CONTENTS:		
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 the fundamental characteristics of electrical motors.	K2
CO2	Classify AC and DC electric drives and explain their stability considerations.	K2
CO3	Illustrate the physical modelling of electrical drives to determine their frequency and transient responses.	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 CONTENTS:		
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: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

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

COURSE OUTCOMES :

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's taxonomy)
CO1	Explain the fundamentals of CMOS technology.	K2
CO2	Describe CMOS chip design techniques.	K2
CO3	Explain various CMOS testing strategies.	K2
CO4	Describe digital design using programmable logic devices (PLDs).	K2
CO5	Illustrate the design of digital circuits using a hardware description language (HDL).	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 CONTENTS:		
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: Nil

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 fundamental concepts of wearable technology and different interfacing methodologies.	K2
CO2	Explain the methods used for nanofibre production.	K2
CO3	Describe the properties and applications of electroactive fabrics.	K2
CO4	Explain the role of strain sensors in wearable devices.	K2
CO5	Summarize the applications of wearable technology in various 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 CONTENTS:		
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: Nil

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	Explain the representation and characteristics of signals in the digital domain.	K2
CO2	Describe the fundamental concepts of virtual instrumentation (VI).	K2
CO3	Explain the standards applicable to virtual instrumentation systems.	K2
CO4	Illustrate the fundamental concepts of graphical programming.	K2
CO5	Apply analysis tools and develop simple programs using virtual instrumentation 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	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 CONTENTS:		
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 methods of converting continuous-time systems into discrete-time systems and the need for digital control systems.	K2
CO2	Apply Z-transforms to solve difference equations and obtain pulse transfer functions.	K3
CO3	Design compensators using time-domain and frequency-domain methods.	K4
CO4	Develop state-space models of discrete-time systems, determine their controllability and observability, and design controllers using pole placement.	K3
CO5	Apply Lyapunov theorems to analyze system stability and apply optimal control techniques to linear and 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 CONTENTS:		
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: Nil

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 and applications of nonlinear systems.	K2
CO2	Explain the different types of bifurcations in one-dimensional nonlinear systems.	K2
CO3	Explain the different types of bifurcations in two-dimensional nonlinear systems.	K2
CO4	Describe the existence of limit cycles and their implications in nonlinear systems.	K2
CO5	Explain the fundamental concepts and characteristics of 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 CONTENTS:		
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: Linear Control System

RELATED COURSES: Nil

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 the Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) to analyze given signals.	K3
CO2	Design digital Infinite Impulse Response (IIR) filters based on given specifications.	K3
CO3	Design digital Finite Impulse Response (FIR) filters based on given specifications.	K3
CO4	Apply basic digital signal processing concepts using DSP processors and analyze finite word-length effects on digital filters.	K3
CO5	Explain the fundamental concepts and applications of multirate signal processing.	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 CONTENTS:		
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

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 different types of signals and systems, and perform basic signal operations such as shifting and scaling.	K2
CO2	Apply Fourier series and Fourier transform techniques to analyze signals.	K3
CO3	Apply Laplace transform techniques to analyze basic electrical circuits.	K3
CO4	Explain the sampling process and its significance in signal processing.	K2
CO5	Apply the Z-transform technique to analyze discrete-time signals.	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 CONTENTS:		
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 fundamental concepts of soft computing techniques.	K2
CO2	Explain the fundamental concepts and architectures of artificial neural networks.	K2
CO3	Explain the fundamental concepts and principles of fuzzy logic.	K2
CO4	Illustrate the basic concepts and operations of genetic algorithms.	K2
CO5	Explain hybrid soft computing techniques and their 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 CONTENTS:

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: Nil

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 the fundamental concepts and applications of biomedical engineering.	K2
CO2	Explain the operating principles of various sensing and measurement devices used in biomedical applications.	K2
CO3	Illustrate the operating principles and applications of devices used to measure non-electrical physiological parameters.	K2
CO4	Apply appropriate techniques for pulmonary measurement and biomedical telemetry.	K3
CO5	Explain modern medical imaging techniques and biometric 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	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 CONTENTS:		
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: Nil

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	Explain the fundamental concepts and architecture of Programmable Logic Controllers (PLCs).	K2
CO2	Develop ladder diagrams using timers and counters for PLC-based applications..	K3
CO3	Apply PLC programming and addressing techniques to solve industrial automation problems.	K3
CO4	Explain the fundamental concepts of Distributed Control Systems (DCS) and apply design principles to basic applications.	K3
CO5	Explain the integration of various DCS components for industrial 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 CONTENTS:

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)
CO1	Determine the MHCP and MSCP of various lighting systems.	K2
CO2	Explain the principles and applications of electric heating, welding, and furnace processes.	K2
CO3	Select suitable electric drives for different applications and calculate the power requirements of motor loads.	K2
CO4	Explain the role and requirements of electrical energy in traction applications.	K2
CO5	Explain electromechanical processes and calculate their 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 CONTENTS:		
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 the national and global energy scenarios.	K2
CO2	Explain energy management principles and energy audit methods.	K2
CO3	Summarize financial management principles and energy performance contracts.	K2
CO4	Explain energy-related aspects of electrical systems.	K2
CO5	Illustrate the operational aspects of compressed air systems through relevant case studies.	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 CONTENTS:

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 the Indian Electricity Rules and Acts and their significance in electrical safety.	K2
CO2	Explain the need for electrical safety in different environments and locations.	K2
CO3	Describe the electrical safety requirements during the installation of electrical equipment.	K2
CO4	Explain the electrical safety requirements and precautions in hazardous areas.	K2
CO5	Describe electrical safety practices in distributed electrical 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 CONTENTS:

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: 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.
- 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 the different renewable energy resources and their importance.	K2
CO2	Explain the process of photovoltaic power generation.	K2
CO3	Explain the process of electrical power generation using wind energy.	K2
CO4	Describe the techniques used for biomass conversion and biogas production.	K2
CO5	Explain the fundamental principles and applications of geothermal energy, tidal energy, magnetohydrodynamic (MHD) power generation, 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						H	
CO2	H						M						H	M
CO3	H						M						H	M
CO4	H						M						H	M
CO5	H						M						H	M

COURSE CONTENTS:		
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 solar energy technologies and their applications.	K2
CO2	Explain the fundamental principles of photovoltaic energy conversion.	K2
CO3	Explain the technologies and processes involved in solar cell fabrication.	K2
CO4	Predict the performance of solar array systems under specified operating conditions.	K3
CO5	Summarize the applications of solar photovoltaic 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								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 CONTENTS:

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: Nil

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 wind measurement techniques.	K2
CO2	Summarize the types of wind turbines and the aerodynamic principles governing their operation.	K2
CO3	Explain the construction and functions of the major components of wind turbines.	K2
CO4	Explain the functions of power management and grid monitoring units in wind energy systems.	K2
CO5	Explain the operation and maintenance requirements throughout the wind energy system life cycle.	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 CONTENTS:		
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: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

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

COURSE OUTCOMES:

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

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Interpret different load forecasting techniques.	K2
CO2	Explain the reliability indices used to assess power generation systems.	K2
CO3	Illustrate the fundamental concepts of the Generation Expansion Planning (GEP) problem.	K2
CO4	Analyze the effects of Demand-Side Management (DSM) and Supply-Side Management (SSM) activities on Generation Expansion Planning (GEP).	K4
CO5	Analyze the impacts of renewable energy integration on environmental pollution and power system reliability.	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	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 CONTENTS:

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: Nil

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 into electrical power using photovoltaic (PV) systems.	K2
CO2	Describe the performance parameters of PV systems.	K2
CO3	Explain the characteristics of solar cells and the design principles of solar PV systems.	K2
CO4	Identify the components of PV systems and explain their installation practices.	K2
CO5	Apply the fundamental principles of solar PV systems and implement appropriate 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: Nil

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	Explain the types of nanotechnology and molecular technology, and explain the methods used for nanomaterial preparation.	K2
CO2	Explain the fundamental principles of logic devices, field-effect devices, and spintronic devices.	K2
CO3	Describe the operating principles of silicon MOSFETs and quantum transport devices.	K2
CO4	Summarize the types, synthesis methods, interconnects, and applications of carbon nanotubes.	K2
CO5	Explain the concepts, functions, fabrication methods, 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 CONTENTS:

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: Nil

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	Identify issues related to environmental sustainability and explain the need for greener electronic design and manufacturing practices in local industries.	K2
CO2	Explain major environmental regulations applicable to electronics in different countries and the importance of compliance.	K2
CO3	Apply the principles and practices of green electronics to selected consumer products.	K3
CO4	Describe the methods used to assess environmental hazards and identify measures to mitigate them.	K2
CO5	Explain the impact of environmental regulations on the design, supply chain, manufacturing, and recycling of 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 CONTENTS:		
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		

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: Nil

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 fundamentals of automotive systems and transmission systems.	K2
CO2	Explain the functions of sensors and actuators used in automotive applications.	K2
CO3	Explain various analog and digital control methods used in automotive systems.	K2
CO4	Describe the architecture and design principles of automotive electronic control units (ECUs).	K2
CO5	Explain the 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 CONTENTS:		
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		

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	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Interface automotive sensors and actuators with specified microcontrollers.	K3, S4
CO2	Design an automotive electronic system for monitoring engine performance and supporting infotainment and telematics applications.	K6, S4
CO3	Identify appropriate communication protocols for vehicle networking.	K1, 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 CONTENTS: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 : 30 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 fundamental concepts and principles of optoelectronics.	K2
CO2	Explain different types of display devices and explain the operating principles of lasers.	K2
CO3	Classify different types of photodetectors and explain their operating principles.	K2
CO4	Explain the operating principles and applications of optical modulators and switching devices.	K2
CO5	Explain integration methods, materials, optoelectronic integrated circuit (OEIC) transmitters and 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 CONTENTS:		
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
		0	0	2	1

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: Nil

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 electronic circuits and perform various analyses to evaluate their performance.	S3
CO2	Design a printed circuit board (PCB) layout for a given electronic circuit.	S4
CO3	Fabricate the PCB and assemble the electronic 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 CONTENTS: 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.

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: Nil

RELATED COURSES: Nil

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 equipment 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 fundamental concepts of human anatomy and physiology.	K2
CO2	Explain the operating principles of various medical electronic instruments.	K2
CO3	Explain the principles and applications of transducers, sensors, and bioelectrical measurement systems.	K2
CO4	Describe patient monitoring systems and physiological measurement techniques.	K2
CO5	Explain the safety requirements and standards applicable to medical 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	L				L							L		
CO2	L		M	L	M							M	L	
CO3	M		L	M										
CO4	L		M	M								M		
CO5	M		L	L	M				M		M	M		

COURSE CONTENTS:		
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: 10212EE166	Course Title: POWER SEMICONDUCTOR MATERIALS	L	T	P	C
		3	0	0	3

COURSE CATEGORY: Programme Elective

PREAMBLE: This course provides an introduction to basic operation of Si, SiC and GaN wide band gap power devices.

PREREQUISITE COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Learn about fundamentals of wide band gap power devices.
- Know about the physics of Si, SiC and GaN materials.

COURSE OUTCOMES:

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

CO No.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain the basic operating principles of silicon (Si) and wide-bandgap power semiconductor devices.	K2
CO2	Explain the fundamental design principles of power semiconductor devices.	K2
CO3	Interpret the specifications and ratings of commercially available power semiconductor devices.	K2
CO4	Describe the characteristics and operating principles of high-power silicon MOSFETs.	K2
CO5	Explain the physical principles underlying gallium nitride (GaN) and silicon carbide (SiC) power MOSFETs.	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
CO2	H	M	M		L								M	M
CO3	H	M	M		L								M	M
CO4	H	M	M		L								M	M
CO5	H	M	M		L								M	M

COURSE CONTENTS:

UNIT I INTRODUCTION **9**

Introduction to basic power devices, characteristics and applications, material properties of Si and wide band gap (WBG) semiconductors, ideal specific on-resistance for Si and WBG device.

UNIT II Si AND SiC PLANAR POWER MOSFETs **9**

Planar power MOSFETs: Forward conduction and forward blocking, Channel mobility, Design of Si and

SiC planar power MOSFETs, Dynamic operation, Unclamped inductive switching and short circuit time, Latch up and Safe Operating Area (SOA), Commercial specifications of Si and SiC planar power MOSFETs, Reliability issues.

UNIT III Si AND SiC IGBTs 9

Si and SiC IGBTs: Structure and Operation, Symmetric and Asymmetric designs, Forward conduction, Forward blocking, Dynamic operation and dependence on lifetime, Latch up and Safe Operating Area (SOA), Design and processing of SiC power devices.

UNIT IV Si HIGH POWER MOS DEVICES 9

VMOS, VDMOS, UMOS, DMOS, LDMOS, DeMOS and Dual trench MOS; Process flow, discrete and On-chip device manufacturing technology; High power MOS design essentials, breakdown voltage and on-resistance trade-off, parasitic capacitance and resistances, DC, RF and switching characteristics.

UNIT V GaN and SiC POWER DEVICES 9

Advantage of high bandgap materials, High bandgap material physics, various GaN/SiC devices, device physics and design essentials, GaN/SiC device manufacturing technology; breakdown voltage and on-resistance trade-off, parasitic capacitance and resistances, DC, RF and switching characteristics, State-of-the-art GaN/SiC devices and ongoing research.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Semiconductor physics and devices, Donald Neamen
2. Advanced Power MOSFET Concepts, B. Jayant Baliga, 2010

REFERENCE BOOKS:

1. B Jayant Baliga, Gallium Nitride and Silicon Carbide Power Devices, North Carolina State University, USA, World Scientific, 2017.
2. Advanced High Voltage Power Device Concepts, B. Jayant Baliga, 2011

COURSE CODE: 10212EE167	COURSE TITLE: POWER SYSTEM AUTOMATION	L	T	P	C
		3	0	0	3

COURSE CATEGORY: Programme Elective

PREAMBLE:. This course introduces a fundamental knowledge on automation technologies in power system**.**

PREREQUISITE COURSES: Nil

COURSE EDUCATIONALOBJECTIVES:

The objectives of the course are to,

- Learn the fundamentals of automation and the building blocks of automation system for power grid.
- Study different communication in power system automation and also to understand the importance in power systems.
- Understand the role of sub-station in the power network, component of sub-station automation, building sub-station automation (SA) systems.
- Understand the use of energy management systems (EMS) and wide-area measurement systems (WAMS) in distribution automation (DA) system.
- Understand the need for distribution automation, power system security requirements, systems, standards etc.

COURSEOUTCOMES:

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	Summarize the fundamentals of power system automation.	K2
CO2	Classify different communication in power system automation.	K2
CO3	Explain power system automation architectures.	K2
CO4	Express the objectives and importance of EMS and WAMs in power systems.	K2
CO5	Describe substation and feeder automations.	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	L					L		M	
CO2	M				M	L					L		M	
CO3	M				M	L					L		M	
CO4	M				M	L					L		M	
CO5	M				M	L					L		M	

COURSE CONTENTS:		
UNIT I	**AUTOMATION FUNDAMENTALS**	**9**
History of automation systems, Supervisory control and data acquisition (SCADA) in power systems, SCADA control centre, Building blocks of SCADA systems: Remote terminal unit (RTU), Intelligent electronic devices (IEDs), Data concentrators and merging units, SCADA communication systems and Master station, Classification of SCADA systems.		
UNIT II	**COMMUNICATION SYSTEM FOR AUTOMATION**	**9**
SCADA communication requirements, Smart grid communication infrastructure, SCADA communication topologies, SCADA data communication techniques, SCADA communication protocol architecture, Evolution of SCADA communication protocols, SCADA and smart grid protocols, Media for SCADA and smart grid communication.		
UNIT III	**SUBSTATION AUTOMATION**	**9**
Need for substation automation, Conventional substations, Islands of automation, Smart devices for substation automation and integrated digital substation. Substation automation: Technical issues, new digital substation, Substation automation architectures, renewable versus existing substations, Substation automation application functions, Data analysis: Benefits of data warehousing.		
UNIT IV	**ENERGY MANAGEMENT SYSTEMS (EMS) FOR CONTROL CENTRES**	**9**
Operating states of the power system and sources of grid vulnerability, Energy control centres, EMS framework, Data acquisition and communication, Generation operation and management, Transmission operations and management: Real time, Study-mode simulations, Post-event analysis and energy scheduling and accounting, Dispatcher training simulator, Smart transmission, EMS with WAMS, Future trends in EMS and DMS with WAMS.		
UNIT V	**DISTRIBUTION AUTOMATION AND DISTRIBUTION MANAGEMENT (DA/DMS)SYSTEMS**	**9**
Introduction to distribution automation, Subsystems in a distribution control centre, DMS framework: Integration with subsystems, DMS application functions, Advanced real-time DMS applications, DMS coordination with other systems, Customer automation, functions, Social media usage for improved reliability and customer satisfaction, Future trends in DA and DMS.		
		TOTAL:45PERIODS

TEXTBOOKS:

1. Mini S. Thomas and John Douglas McDonald, “Power System SCADA and Smart Grids”, CRC Press, 2015.
2. Gilbert N. Sorebo and Michael C. Echols “Smart Grid Security - An End-to-End View of Security in the New Electrical Grid”, CRC Press, 2012.

REFERENCEBOOKS:

1. Ulf Häger, Christian Rehtanz and Nikolai Voropai, “Monitoring, Control and Protection of Interconnected Power Systems”, Springer, 2014
2. Eveliopadilla “Sub-Station automation – Systems design and implementation”, Wiley , 2016
3. Stuart A. Boyer “SCADA : supervisory control and data acquisition”, ISA, 2004
4. Robert RadvanovskyJacob Brodsky “SCADA /Control Systems Security”, CRC Press , 2013

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE201	**APPLIED SOFT COMPUTING**	**2**	**0**	**2**	**3**

COURSE CATEGORY: Programme Elective (Integrated course)

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	Explain the processes of fuzzification and defuzzification in a fuzzy logic controller.	K2
CO2	Explain the architecture of artificial neural networks and the principles of supervised and unsupervised learning.	K2
CO3	Explain the concepts and steps involved in genetic algorithms and differential evolution algorithms.	K2
CO4	Explain the steps involved in various optimization algorithms and apply them to given optimization problems.	K3
CO5	Develop MATLAB-based simulation models to solve 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 CONTENTS:		
UNIT I	**FUZZY LOGIC**	**7**
Fuzzy sets- logic operations and relation, fuzzy decisions making, fuzzy inference systems, design of fuzzy logic controller.		
UNIT II	**ARTIFICIAL NEURAL NETWORKS**	**7**
Artificial neuron-Supervised and unsupervised learning-single layer perceptron, and multi-layer perceptron, back propagation neural network.		
UNIT III	**EVOLUTIONARY ALGORITHM**	**7**
Genetic algorithms: Introduction-genetic algorithm steps-selection, crossover, and mutation-Deferential Evolution Algorithm		
UNIT IV	**SWARM INTELLIGENCE**	**9**
Particle swarm optimization (PSO)-Firefly algorithm (FA), Artificial BEE optimization (ABC) -Cat swarm optimization (CSO)-Bacterial foraging optimization(BFO)		
LIST OF EXPERIMENTS		**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) Swarm intelligence for optimization problem in electrical engineering		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. S.N.Sivanandam and S.N.Deepa, 'Principles of Soft Computing', Wiley India Pvt Ltd, 2011. 2. 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. VijayalakshmiPai,'Neural Networks, Fuzzy Logic & Genetic Algorithms", PHI, New Delhi 3. Deb, K., 'Optimization for Engineering Design Algorithms and Examples', Prentice Hall of India. 2009. 4. George J. Klir, Ute St. Clair, Bo Yuan, 'Fuzzy Set Theory: Foundations and Applications' Prentice Hall, 1997.		

COURSE CODE: **10212EE202**	COURSE TITLE: **SWITCH MODE POWER SUPPLY DESIGN AND DEVELOPMENT**	L	T	P	C
		2	**0**	**2**	**3**

COURSE CATEGORY: Programme Elective -Integrated

PREAMBLE: This course is designed from understanding the fundamental of SMPS in designing an SMPS for the given equipment.

PREREQUISITE COURSES: Nil

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 concepts and operating principles of switched-mode power supplies (SMPS).	K2
CO2	Explain the operation of rectifiers, choppers, amplifier circuits, and voltage and current sensors used in SMPS.	K2
CO3	Explain the different SMPS topologies and their operating principles.	K2
CO4	Design an SMPS for a specified application based on given requirements.	K6
CO5	Identify power quality issues using a 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 CONTENTS:

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: Nil

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 operating principles of DC generators.	K2
CO2	Explain the performance characteristics of DC motors.	K2
CO3	Explain the operating principles and equivalent circuit of transformers.	K2
CO4	Explain the fundamental concepts and operating principles of synchronous machines.	K2
CO5	Explain the operating principles and performance characteristics of single-phase and polyphase 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	L	L			H	M
CO2	H	H	M	M				L	L	L			H	M
CO3	H	H	M	L				L	L	L			H	M
CO4	H	H		L				L	L	L	M		H	M
CO5	H	H		H				L	L	L			H	M

COURSE CONTENTS:		
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 three 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 (Lab course)

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: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of this course are to,

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

COURSE OUTCOMES:

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

CO Nos.	**Course Outcomes**	**Level of learning domain (Based on revised Bloom's taxonomy)**
CO1	Explain the fundamental concepts and operating principles of voltage stabilizers.	K2, S1
CO2	Construct a transformer for use in a voltage stabilizer.	K3, S2
CO3	Construct a relay driver circuit for a voltage stabilizer.	K3, S2
CO4	Demonstrate the operation of a voltage stabilizer for a specified application.	K3, S3
CO5	Troubleshoot voltage stabilizers to identify and rectify faults.	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 CONTENTS:

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)

S.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
28.	10213EE130	Wind and Solar Power System	3	0	0	3
INTEGRATED COURSES						
29.	10213EE201	Switch Mode Power Supply Design and Development	2	0	2	3
LABORATORY COURSES						
30.	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)
CO1	Illustrate the fundamental concepts and architecture of feedforward neural networks.	K2
CO2	Illustrate the fundamental concepts and architecture of feedforward neural networks.	K2
CO3	Analyze and compare fuzzy set theory with conventional set theory.	K3
CO4	Explain the fundamental concepts of fuzzy systems and the structure of a fuzzy logic controller.	K2
CO5	Identify the applications of fuzzy logic control in 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 CONTENTS:		
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: **BIOMEDICAL 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: Nil

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)
CO1	Explain the physiology of the heart, blood circulation, and respiration, along with the transducers used for physiological measurements.	K2
CO2	Describe various electrical sensing and measurement devices and instruments used to assess medical equipment safety parameters.	K2
CO3	Explain the operating principles and applications of devices used to measure non-electrical physiological parameters.	K3
CO4	Explain the principles and applications of pulmonary measurement and biomedical telemetry.	K2
CO5	Describe modern medical imaging techniques and biometric 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	L		H								M		L	M
CO2	M							L			L		L	
CO3			M								M			
CO4			H					M			M			
CO5			M										L	M

COURSE CONTENTS:		
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 fundamental concepts and architecture of Programmable Logic Controllers (PLCs).	K2
CO2	Develop ladder diagrams using timers and counters for specified automation applications.	K3
CO3	Apply PLC programming and addressing techniques to solve industrial automation problems.	K3
CO4	Explain the fundamental concepts and design principles of Distributed Control Systems (DCS).	K3
CO5	Explain the integration of various DCS components for industrial 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 CONTENTS:		
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, 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	Explain the representation of analog signals in the digital domain.	K2
CO2	Apply calibration and resolution concepts to analog inputs and outputs using Data Acquisition (DAQ) systems.	K3
CO3	Interface external instruments with a PC by selecting appropriate communication buses.	K3
CO4	Explain graphical programming techniques used in virtual instrumentation.	K2
CO5	Develop programs for simple applications using Virtual Instruments (VIs).	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													
CO2	M	H	H		H									
CO3	M	H	H		H									
CO4	M	L			H									
CO5	M	H	H		H									

COURSE CONTENTS:

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. 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	Explain the fundamental concepts and criteria of the Finite Element Method (FEM).	K2
CO2	Explain the basic concepts and characteristics of discrete elements.	K2
CO3	Describe the types and characteristics of continuum elements.	K2
CO4	Explain the applications of isoparametric elements in finite element analysis.	K2
CO5	Explain the applications of the Finite Element Method to problems in various engineering 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	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 CONTENTS:

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

TEXT BOOKS:

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	Explain the fundamental concepts of Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC).	K2
CO2	Explain various grounding techniques used to minimize electromagnetic interference.	K2
CO3	Explain the importance and principles of shielding in electromagnetic compatibility.	K2
CO4	Explain the sources and effects of noise in digital circuits.	K2
CO5	Describe industrial and government standards related to electromagnetic interference.	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 CONTENTS:

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. 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 : Nil

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 in electrical power systems.	K2
CO2	Describe power quality problems, their categories, causes, and effects.	K2
CO3	Explain the role of power quality standards and charts in assessing power quality.	K2
CO4	Classify linear and nonlinear loads based on their characteristics.	K2
CO5	Summarize the operating principles and applications of 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

TEXT BOOKS:

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	Illustrate the fundamental elements, laws, and quantities of illumination and the principles of optical design.	K2
CO2	Classify LED lighting technologies and different types of lighting systems.	K2
CO3	Describe the types and operating principles of power electronic circuits used in LED lighting systems.	K2
CO4	Summarize lighting control strategies, building lighting control systems, and their applications.	K2
CO5	Explain the basic principles of PCB design for LED lighting systems, including troubleshooting and maintenance 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	M		H					M						
CO2		M				M								
CO3	H		M					M		M				
CO4					M									
CO5														

COURSE CONTENTS:		
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

TEXT BOOKS:

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: Nil

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 various transducers used to measure parameters such as displacement, temperature, and pressure.	K2
CO2	Explain the static and dynamic characteristics of transducers.	K2
CO3	Illustrate the types of transducers and their applications in measurement systems.	K2
CO4	Summarize the principles of virtual instrumentation for data acquisition.	K2
CO5	Differentiate various types of sensors based on their operating principles and 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

TEXT BOOKS:

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: Nil

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 various types of signals and systems and illustrate signal operations such as shifting and scaling.	K2
CO2	Apply Fourier series and Fourier transforms to analyze signals.	K3
CO3	Apply Laplace transforms to analyze basic electrical circuits.	K3
CO4	Explain the sampling process and its significance in signal processing.	K2
CO5	Apply the Z-transform technique to analyze discrete-time signals.	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													
CO2	H							H		M	H			
CO3	H			H				H		M	H			
CO4		M	M	L		M		M		M				
CO5										H				

COURSE CONTENTS:		
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

TEXT BOOKS:

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: Nil

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	Explain the concept of wearable technology and various interfacing methodologies.	K2
CO2	Describe the methods used for the production of nanofibres.	K2
CO3	Illustrate the principles and characteristics of sensing fabrics and actuating fabrics.	K2
CO4	Explain the operating principles and applications of strain sensors used in wearable devices.	K2
CO5	Summarize the applications of wearable technology in various 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 CONTENTS:		
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

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:	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 definition, components, and requirements of embedded systems.	K2
CO2	Describe processor architectures and memory organization in embedded systems.	K2
CO3	Apply interfacing and communication techniques in embedded systems.	K3
CO4	Explain input/output operations, testing methods, and applications of embedded systems.	K2
CO5	Describe the characteristics, requirements, and challenges 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 CONTENTS:		
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: This course will make the students to understand the methods/procedure of estimating, tendering/ contracting in electrical wiring. 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: Nil.

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)
CO1	Explain the symbolic representation of electrical wiring materials and components.	K2
CO2	Describe the methods used to estimate the quantities and costs of materials in accordance with the Indian Electricity Rules and applicable regulations.	K2
CO3	Explain the specifications and standards applicable to electrical wiring installations.	K2
CO4	Classify different types of electrical wiring systems and describe their characteristics.	K2
CO5	Summarize the procedures for estimating material quantities and costs for electrical projects in accordance with applicable electrical regulations.	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			H			M			
CO2			L		L			H			L			
CO3	M		M	L										
CO4			H		L			L						
CO5	M		M	H							H			

COURSE CONTENTS:		
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, AND EARTHING**	**9**
Wiring systems – Types of wiring – Looping back system and Joint box system and tree system – Position of switches, main switch board and sub-distribution boards. Considerations for selecting wire size – size of conductors /cable used for Domestic installation, Service connection, Distributors - Materials used as fuse element – Selection of fuse wire - types of fuses. Electric shock – Effects of electric shock – factors influencing the electric shock - Precautions against electric 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: Nil

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 different renewable energy resources and their importance in sustainable energy generation.	K2
CO2	Outline the principles and processes involved in photovoltaic power generation.	K2
CO3	Illustrate the principles and process of electrical power generation using wind energy.	K2
CO4	Describe biomass conversion methods and biogas production techniques.	K2
CO5	Summarize the fundamental principles and applications of geothermal energy, tidal energy, magnetohydrodynamic (MHD) power generation, 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 CONTENTS:

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: Nil

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)
CO1	Identify the basic architecture and major components of automotive electrical systems.	K1
CO2	Explain common faults in vehicle drive systems and their troubleshooting methods.	K2
CO3	Identify different sensor arrangements used in automotive systems.	K1
CO4	Differentiate various control strategies used in automotive systems.	K1
CO5	Explain engine operation and the input parameters used by the Engine Control Unit (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 CONTENTS:		
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: Nil

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)
CO1	List the fundamental principles of vehicle propulsion and braking.	K1
CO2	Illustrate the structure and major components of an electric vehicle.	K2
CO3	Explain the operating principles of hybrid electric vehicles.	K2
CO4	Explain common challenges and limitations associated with regenerative braking.	K2
CO5	Summarize the environmental impacts of electric and hybrid vehicles.	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 CONTENTS:

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)
CO1	Classify different types of robots and illustrate their basic components.	K2
CO2	Explain the principles of robot motion and control.	K2
CO3	Summarize the fundamental concepts and applications of artificial intelligence in robotics.	K2
CO4	Describe the basic concepts and techniques of robot programming.	K2
CO5	Illustrate the applications of robotics in various 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						L								
CO2								H					M	
CO3								H						
CO4			M			M								
CO5										H			H	M

COURSE CONTENTS:

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: Nil

COURSE EDUCATIONAL OBJECTIVES:

- To develop Calibration Professionals capable of handling calibration laboratories & managing calibration system in an organization
- To understand Measurement Units, Standards, Systems, Testing & Calibration, Traceability & Uncertainty, Mathematics &and Applied Statistics
- To 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	Explain measurement standards, systems of units, and their applications.	K2
CO2	Classify measurement methods and describe the characteristics of measurements.	K2
CO3	Illustrate calibration procedures and different calibration methods.	K2
CO4	Summarize the basic statistical and mathematical methods used in measurements.	K2
CO5	Explain measurement uncertainty and describe methods for expressing and reporting 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 CONTENTS:

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: Nil

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	Explain the objectives and precautions of electrical safety, the effects of electric shock, and methods of prevention.	K2
CO2	Describe electrical protection procedures and earthing requirements.	K2
CO3	Summarize the safety requirements during the installation of electrical plants and equipment.	K2
CO4	Explain safe operating procedures and the fundamentals of energy auditing.	K2
CO5	Describe electrical safety management practices and applicable Indian Electricity Rules and regulations.	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 CONTENTS:

UNIT I	ELECTRICAL SAFETY	9

Terms and definitions, objectives of safety and security measures, Hazards associated with electric

current and voltage, principles of electrical safety, Approaches to prevent Accidents, scope of subject electrical safety. Primary and secondary electrical shocks, possibilities of getting electrical shock and its severity, medical analysis of electric shocks and its effects, shocks due to flash/ Spark over's, prevention of shocks, safety precautions against contact shocks, flash shocks, burns, residential buildings and shop.		
UNIT II	**PROTECTION PROCEDURES AND EARTHING**	**9**
Introduction, Types and objectives of protection, Classification of Earthing, Functional requirements of relays, system protection concepts. Importance of Earthing, Line and Pole Earthing, Guidelines for providing earthing arrangements, maintenances of earthing system.		
UNIT III	**SAFETY DURING INSTALLATION OF EQUIPMENT**	**9**
Introduction, preliminary preparations, preconditions for start of installation work, during, risks during installation of electrical equipment, safety aspects during installation, personal protective equipment for erection personnel, installation of a large oil immersed power transformer, safety during installation of electrical rotating machines, drying out and insulation resistance measurement of rotating machines.		
UNIT IV	**SAFE OPERATING PROCEDURES**	**9**
Principles of Safety Management, Management Safety Policy, Safety organization, safety auditing, Motivation to managers, supervisors, employees.		
UNIT V	**REGULATIONS**	**9**
Objective and scope – ground clearances and section clearances – standards on electrical safety - safe limits of current, voltage –Rules regarding first aid and fire fighting facility. The Electricity Act, 2003, (Part1, 2, 3,4 & 5)		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. S. Rao, Prof. H.L. Saluja, "Electrical safety, fire safety Engineering and safety management", Khanna Publishers. New Delhi, 1988.(units-I to V) 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. HSC- A Practical Guide Vol. 1 To 4, National Safety Council, India. 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		

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

COURSE CATEGORY: Open Elective

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

PREREQUISITE COURSES: Nil

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	Explain energy consumption, energy management, and energy auditing.	K2
CO2	Explain the energy consumption and capacity of different electrical equipment.	K2
CO3	Explain thermal stability and its significance in electrical equipment.	K2
CO4	Explain energy conservation methods in major electrical devices.	K2
CO5	Explain economically 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 CONTENTS:		
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 operating principles of DC machines.	K2
CO2	Illustrate the theory, operating principles, and phasor diagrams of transformers.	K2
CO3	Describe the fundamental concepts and operating principles of synchronous machines.	K2
CO4	Explain the operating principles of three-phase induction motors.	K2
CO5	Illustrate the operating principles 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			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 CONTENTS:		
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: Nil

COURSE EDUCATIONAL OBJECTIVES :

The objectives of the course are to make the students,

- To introduce various methods of effectively and efficiently utilizing Electrical Energy for different and desired applications.
- To teach the various Electrical Lighting principles and their applications.
- To 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	Identify and describe the basic electrical equipment used in manufacturing industries.	K2
CO2	Illustrate the applications of electrical equipment in different industries.	K2
CO3	Explain the types and operating principles of electric traction systems.	K2
CO4	Summarize the patterns of electrical energy consumption in industries.	K2
CO5	Classify different types of illumination systems and explain their basic principles.	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 CONTENTS:		
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: Nil.

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 Finite Element Analysis (FEA) and classify different types of finite elements.	K2
CO2	Model objects using 1D, 2D, and 3D finite elements and demonstrate different solver techniques using MagNet software.	K3
CO3	Explain the operating principles and types of DC machines and simulate a DC series motor using MagNet software.	K3
CO4	Explain the operating principles and types of transformers and simulate core-type and shell-type transformers using MagNet software.	K3
CO5	Explain the operating principles of squirrel-cage induction motors and simulate their operation 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 CONTENTS:

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: Nil

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 different renewable energy resources and their importance.	K2
CO2	Illustrate the principles and process of photovoltaic power generation.	K2
CO3	Describe the principles and process of electrical power generation using wind energy resources.	K2
CO4	Summarize bioenergy conversion methods and their applications in power generation.	K2
CO5	Outline the fundamental principles and applications of other renewable energy resources.	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 CONTENTS:		
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. 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: Nil

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	Illustrate the fundamental concepts and basic components of robots.	K2
CO2	Explain the functions and applications of different sensors used in robots.	K2
CO3	Describe the types and functions of robotic grippers and robot control systems.	K2
CO4	Outline the programming procedures for robots in typical applications.	K2
CO5	Summarize robot manipulation techniques used in 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**													
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 CONTENTS:		
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: Nil

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	Explain the relationship between wind speed and power generation.	K2
CO2	Classify the major components of a wind turbine tower system.	K2
CO3	Illustrate the design features of wind turbine towers.	K2
CO4	Explain the operating principles of different types of generators used in wind energy systems.	K2
CO5	Describe the operating principles and control methods of wind power generation 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	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 CONTENTS:

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, Site Selection Considerations.

UNIT II	WIND TURBINE COMPONENTS	9
Components of wind energy conversion (WEC) system, Classification of WEC systems, Advantages and Disadvantages of WECS, Types of Wind Machines (Wind Energy Collectors), Yaw control and Pitch control, Energy Storage, Applications of Wind Energy.		
UNIT III	**WIND ENERGY CONVERSION SYSTEM DESIGN**	**9**
Wind Energy Conversion System - Design – Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and combine theory; Rotor characteristics; Maximum power coefficient; Prandlt's tip loss correction.		
UNIT IV	**TYPES OF GENERATORS**	**9**
Generating Systems, Types of Generator: Induction generator, Synchronous generator, Fixed and variable speed operations, Grid integration.		
UNIT V	**CONTROL OF WIND POWER**	**9**
Nature of wind, necessity of MPPT, 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: 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 the Indian Electricity Rules and their significance in electrical safety.	K2
CO2	Describe electrical safety standards applicable to residential, commercial, and agricultural installations.	K2
CO3	Summarize the safety procedures for electrical installation and testing.	K2
CO4	Explain the causes and effects of flashover and corona discharge in electrical systems..	K2
CO5	Describe electrical safety practices and protection measures in distribution 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		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 CONTENTS:		
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: 10213EE130	Course Title: WIND AND SOLAR POWER SYSTEM	L	T	P	C
		3	0	0	3

COURSE CATEGORY: Open Elective

PREAMBLE: The wind and photovoltaic power technologies are rapidly evolving. This course presents a broad overview of wind energy technologies and solar photovoltaic technologies.

COURSE EDUCATIONAL OBJECTIVES

The objectives of the course are to,

- Learn the fundamental knowledge on the onshore and offshore wind power generation system.
- Understand the conversion characteristics of solar photovoltaic system.
- Analyze the different operating modes of solar PV and wind power system.

COURSE OUTCOMES:

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

CO No.	Course Outcomes
CO1	Explain the fundamental concepts and components of wind power systems.
CO2	Differentiate the design features of offshore and onshore wind farms.
CO3	Illustrate the energy conversion characteristics of photovoltaic cells and the principles of PV array design.
CO4	Describe the operating principles of stand-alone solar and wind power systems.
CO5	Explain the operating principles of grid-connected solar and wind energy systems.

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

COURSE CONTENTS:

UNIT I WIND ENERGY SYSTEMS 9

Introduction-Wind Power in the World and India-Speed and Power Relations-Power Extracted from the Wind-Wind Speed Distribution-Wind power System Components- Stand-alone operation-Turbine Rating-System Design Trade-offs-Environmental Aspects.

UNIT II OFFSHORE WIND FARMS 9

Offshore Projects-Environmental Impact-Offshore Costs-Power Transmission to Shore-Ocean Water Composition-Wave Energy and Power-Ocean Structure Design-Corrosion-Foundation

UNIT III	**SOLAR PV SYSTEMS** **9**
Energy conversion-PV Cell Technologies-PV Cell-Module and- Array-Equivalent Electrical Circuit-Open-Circuit Voltage and Short-Circuit Current-I-V and P-V Curves-Array Design-Peak-Power Operation-System Components - PV stand-alone operation.	
UNIT IV	**HYBRID SYSTEMS** **9**
Hybrid Systems : Hybrid with Diesel, Hybrid with Fuel Cell, Mode Controller, Load Sharing-System Sizing: Power and Energy Estimates, Battery Sizing, PV Array Sizing-Wind Farm Sizing	
UNIT V	**GRID-INTEGRATION** **9**
Interface Requirements-Synchronizing with the Grid-Operating Limit-Energy Storage and Load Scheduling-Wind Farm–Grid Integration-Grid code of conducts.	
	TOTAL: 45 PERIODS

TEXT BOOKS:

1. Mukund R.Patel, Wind and Solar Power Systems-Design, Analysis and Operation, Second Edition, Taylor & Francis, 2006.
2. S.N.Bhadra, D.Kastha,S.Banerjee, 'Wind Electrical Systems', Oxford University Press, 2010.

REFERENCE BOOKS:

1. Sathyajith Mathew, 'Wind Energy Fundamentals, Resource Analysis and Economics' Springer (2006).
2. Dr. Sundaravadivelu S, Mr. Suresh R. Norman, Dr. Johnsi Stella I, Dr. Suresh Kumar A, Solar Photovoltaic Power Systems: Principles, Design and Applications, Notion Press, 2017.

COURSE CODE: **10213EE201**	COURSE TITLE: **SWITCH MODE POWER SUPPLY DESIGN AND DEVELOPMENT**	L	T	P	C
		2	**0**	**2**	**3**

COURSE CATEGORY: Open Elective (Integrated course)

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: Nil

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	Explain the fundamental concepts and operating principles of switched-mode power supplies (SMPS).	K2
CO2	Describe the operating principles of rectifiers, choppers, amplifier circuits, and voltage and current sensors used in SMPS.	K2
CO3	Classify different SMPS topologies and explain their operating principles.	K2
CO4	Design an SMPS for a specified application based on given requirements.	K6
CO5	Analyze power quality issues using a power quality analyzer.	K4

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 CONTENTS:		
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 (Lab course)

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	Explain the fundamental concepts and operating principles of voltage stabilizers.	K2
CO2	Design a transformer for a voltage stabilizer based on specified requirements.	K6
CO3	Design a relay driver circuit for a voltage stabilizer.	K6
CO4	Select a suitable voltage stabilizer for a specific application based on its requirements.	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 CONTENTS:

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.	10212EE204	Object Oriented Programming using Java	2	0	2	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
7.	10212EE107	Data Base Systems and Programming	3	0	0	3
8.	10212EE108	Internet of Things	3	0	0	3
9.	10212EE109	Big Data Analytics	3	0	0	3
10.	10212EE110	Cloud Computing	3	0	0	3
11.	10212EE206	Data Structures and Algorithms using C	2	0	2	3

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

COURSE CATEGORY: Programme Elective (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	Explain arithmetic algorithms and procedures for implementing them in hardware.	K2
CO3	Explain instruction pipelining and methods for minimizing hazards in data processing units.	K2
CO4	Summarize the types of input/output devices and standard communication interfaces.	K2
CO5	Apply performance considerations in memory management and digital computer design.	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 CONTENTS:		
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: Programme Elective (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 fundamental concepts, basic structure, and functions of an operating system.	K2
CO2	Apply process management concepts to solve real-time problems.	K3
CO3	Illustrate concurrency concepts and process scheduling algorithms.	K2
CO4	Explain various memory management techniques and their implementation.	K2
CO5	Summarize file management and input/output device management techniques.	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 CONTENTS:		
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: 10212EE204	COURSE TITLE: OBJECT ORIENTED PROGRAMMING USING JAVA	L	T	P	C
		2	0	2	3

COURSE CATEGORY: Programme Elective (Specialization-Integrated)

PREAMBLE: To understand and develop the Java programming language for solving real time problems.

PREREQUISITE COURSES: Nil

RELATED 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	Apply object-oriented programming concepts in Java to solve basic programming problems.	K2
CO2	Apply inheritance and interfaces to develop Java applications for real-time problems.	K3
CO3	Examine Java applications that use exception handling and string manipulation.	K4
CO4	Summarize the use of threads and generic classes in Java applications.	K2
CO5	Illustrate the features and principles of event-driven programming.	K2

CORRELATION OF COs AND POs

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

COURSE CONTENTS :

UNIT I	INTRODUCTION TO OOPS AND JAVA FUNDAMENTALS	6

Java fundamentals: Java architecture – Language Basics – Characteristics of Java – Features of Java – Comments – Data types – Variables – Operators – Type conversion and casting – Flow control

statements – Arrays. OOPS: Classes and objects – Concepts of classes and objects – Creating classes – Methods – Constructors – Static variables and methods – This Keyword – Packages.		
UNIT II	**INHERITANCE AND INTERFACES**	**6**
Inheritance – Super classes – Sub classes – Protected members – Constructors in sub classes – 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	**EXCEPTION HANDLING AND STRINGS**	**6**
String Class – String Buffer Class – Exception handling – Errors vs Exceptions – Exception hierarchy – Usage of try, catch, throw, throws and finally, re-throwing exceptions – Built-in exceptions – User defined exceptions.		
UNIT IV	**MULTITHREADING AND GENERIC PROGRAMMING**	**6**
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**	**6**
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 (L): 30 PERIODS

LIST OF EXPERIMENTS **TOTAL (P): 30 PERIODS**

1. Develop a Java application to generate Electricity bill. Create a class with the following members: Consumer no., consumer name, previous month reading, current month reading, and type of EB connection (i.e. domestic or commercial). Compute the bill amount using the following tariff. **[CO1]**
   a. If the type of the EB connection is domestic, calculate the amount to be paid as follows:
      - First 100 units - Rs. 1 per unit
      - 101-200 units - Rs. 2.50 per unit
      - 201 -500 units - Rs. 4 per unit
      - > 501 units - Rs. 6 per unit
   b. If the type of the EB connection is commercial, calculate the amount to be paid as follows:
      - First 100 units - Rs. 2 per unit
      - 101-200 units - Rs. 4.50 per unit
      - 201 -500 units - Rs. 6 per unit
      - > 501 units - Rs. 7 per unit
2. Develop a java application to implement currency converter (Dollar to INR, EURO to INR, Yen to INR and vice versa), distance converter (meter to KM, miles to KM and vice versa), using packages. **[CO1]**
3. Develop a java application with Employee class with Emp_name, Emp_id, Address, Mail_id, Mobile_no as members. Inherit the classes, Programmer, Assistant Professor, Associate

Professor and Professor from employee class. Add Basic Pay (BP) as the member of all the inherited classes with 97% of BP as DA, 10 % of BP as HRA, 12% of BP as PF, 0.1% of BP for staff club fund. Generate pay slips for the employees with their gross and net salary. **[CO2]**

4. Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named print Area (). Provide three classes named Rectangle, Triangle and Circle such that each one of the classes extends the class Shape. Each one of the classes contains only the method print Area () that prints the area of the given shape. **[CO2]**
5. Develop a java program using String Class. **[CO3]**
6. Write a java program to implement Exception Handling mechanism. **[CO3]**
7. Write a java program that implements a multi-threaded application that has three threads. First thread generates a random integer at every 1 second and if the value is even, second thread computes the square of the number and prints. If the value is odd, then the third thread will print the value of the cube of the number. **[CO4]**
8. Write a java program to find the maximum value from the given type of elements using a generic function. **[CO4]**
9. Write a Java program that works as a simple calculator. Use a grid layout to arrange buttons for the digits and for the +, -,*, % operations. Add a text field to display the result. Handle any possible exceptions like divide by zero. **[CO5]**
10. Develop an Applet that receives an integer in one text field & compute it factorial value & returns it in another text filed when the button "Compute" is clicked. **[CO5]**

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.

ONLINE RESOURCES:

a. "Programming in Java", Accessed on: Apr. 20, 2021 [Online], Available: https://nptel.ac.in/courses/106/105/106105191/

b. "Java Tutorial", Accessed on: Apr. 20, 2021 [Online], Available: https://www.javatpoint.com/java-tutorial

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

COURSE CATEGORY: Programme Elective (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 and linear data structures used to solve real-world problems.	K2
CO2	Implement modular programs using nonlinear data structures and algorithms to solve engineering problems efficiently.	K3
CO3	Illustrate specialized trees and hashing techniques.	K2
CO4	Apply searching techniques in graph traversal algorithms.	K3
CO5	Apply sorting techniques to solve 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 CONTENTS :		
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:	COURSE TITLE:	L	T	P	C
10212EE105	**COMPUTER NETWORKS AND COMMUNICATION**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective (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: Nil

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 fundamental building blocks of communication networks.	K2
CO2	Explain different network topologies and network performance metrics.	K2
CO3	Summarize error detection and correction mechanisms, flow control techniques, and routing protocols.	K2
CO4	Compare the performance of network-layer and transport-layer protocols.	K3
CO5	Explain the functions of different network layers and their 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 CONTENTS :

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: Programme Elective (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: Nil

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 AI search algorithms for real-world applications.	K2
CO2	Explain problem-solving methods using first-order logic and predicate logic.	K2
CO3	Develop logical representations and knowledge bases to solve given problems.	K3
CO4	Develop software agents to solve given problems.	K3
CO5	Select suitable natural language processing (NLP) applications 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 CONTENTS :		
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.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE107	**DATABASE SYSTEMS AND PROGRAMMING**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Program Elective **(**Specialization)

PREAMBLE: To study the need of Relational Database design for efficient storage and manipulation of data exposed to different applications.

PREREQUISITE COURSES: NIL

RELATED COURSES: NIL

COURSE EDUCATIONAL OBJECTIVES :

- To provide a general introduction to relational model
- To learn about ER diagrams
- To learn about Query Processing and Transaction Processing

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 concepts and principles of database management systems.	K2
CO2	Summarize relational database schemas and their components.	K2
CO3	Explain SQL concepts and relational database design principles.	K2
CO4	Describe internal storage structures using different file organization and indexing techniques.	K2
CO5	Illustrate concurrency control techniques and recovery procedures for reliable database operation.	K2

CORRELATION OF COs AND POs

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

COURSE CONTENT :		
UNIT I	**DBMS INTRODUCTION**	**9**
The Evolution of Database Systems- Overview of a Database Management System-Outline of Database-System Studies-The Entity. Relationship data model: Elements of the E/R Model-Design Principles-The Modeling of Constraints-Weak Entity Sets		
UNIT II	**DATA MODEL & ALGEBRA**	**9**
Basics of the Relational Model-From E/R Diagrams to Relational Designs- Converting Subclass Structures to Relations Functional Dependencies-Rules About Functional Dependencies-Design of Relational Database Schemas - Multivalued Dependencies.		
UNIT III	**STRUCTURED QUERY LANGUAGE**	**9**
Database Modifications-Defining a Relation Schema-View Definitions- Constraints and Triggers: Keys and Foreign Keys-Constraints on Attributes and Tuples- Modification of Constraints-Schema- Level Constraints and Triggers –Java Database Connectivity- Security and User Authorization in SQL		
UNIT IV	**INDEX STRUCTURE**	**9**
Indexes on Sequential Files-Bitmap Indexes. Query execution: Physical-Query-Plan Operators-One-Pass , two-pass & index based Algorithms, Buffer Management, Parallel Algorithms-Estimating the Cost of Operations-Cost-Based Plan Selection -Order for Joins-Physical-Query- Plan		
UNIT V	**CONCURRENCY CONTROL**	**9**
Issues and Models for Resilient Operation -Undo/Redo Logging-Protecting against Media Failures- Concurrency control: Serial and Serializable Schedules-Conflict Serializability-Enforcing Serializability by Locks-Locking Systems with Several Lock Modes-concurrency Control by Timestamps, validation.		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. Hector Garcia-Molina, Jeff Ullman, and Jennifer Widom, “Database Systems: The Complete Book,” Pearson Education, Second Edition, 2008.		
REFERENCE BOOKS:		
1. Silberschatz, H. Korth and Sudarshan S, “Database System Concepts”, 6th Edition, McGraw-Hill International, 2010 2. Elmasri R. and Shamakant B. Navathe, “Fundamentals of Database Systems”, 6th Edition, Addision Wesley , 2011.		

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE108	**INTERNET OF THINGS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Program Elective (Specialization)

PREAMBLE: To understand the concepts of Internet of Things (IoT) and its applications in Data Analytics and implementation of web-based services on IoT Platform

PREREQUISITE COURSES: NIL

RELATED COURSES: NIL

COURSE EDUCATIONAL OBJECTIVES

- To Understand the terminology, technology and its applications
- To explain the concept of M2M (machine to machine) with necessary protocols
- To explain the Python Scripting Language which is used in many IoT devices
- To familiarize with Raspberry PI platform, that is widely used in IoT applications
- To explain the implementation of web-based services on IoT 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	Interpret the impact and challenges of IoT networks and their influence on emerging architectural models.	K2
CO2	Compare and contrast smart-object deployment methods and technologies used to connect them to networks.	K2
CO3	Explain the role of Python in enabling effective network communication in IoT applications.	K2
CO4	Explain the importance of data analytics and security in IoT systems.	K2
CO5	Illustrate different sensor technologies used to sense real-world entities and identify industrial IoT applications.	K2

CORRELATION OF COs AND POs

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

COURSE CONTENT :		
UNIT I	**INTRODUCTION TO IOT**	**9**
Definition and Characteristics, Physical Design – IoT Protocols, IoT communication models, IoT enabled Technologies –Wireless Sensor Networks, Cloud Computing, Big data, Communication protocols, IoT Levels and Templates Domain Specific IoTs – Home, City, Environment, Energy, Retail, Logistics, Agriculture, Industry, health and Lifestyle		
UNIT II	**NETWORK FUNCTIONS**	**9**
Software defined networks, network function virtualization, difference between SDN and NFV for IoT Basics of IoT System Management with NETCOZF, YANG- NETCONF, YANG, SNMP NETOPEER		
UNIT III	**PYTHON INTRODUCTION**	**9**
Language features of Python, Data types, data structures, Control of flow, functions, modules, packaging, file handling, data/time operations, classes, Exception handling Python packages - JSON, XML, HTTPLib, URLLib, SMTPLib		
UNIT IV	**IOT PHYSICAL DEVICES AND ENDPOINTS**	**9**
Introduction to Raspberry PI-Interfaces (serial, SPI, I2C) Programming – Python program with Raspberry PI with focus of interfacing external gadgets, controlling output, reading input from pins.		
UNIT V	**IOT PHYSICAL SERVERS AND CLOUD OFFERINGS**	**9**
Introduction to Cloud Storage models and communication APIs Webserver – Web server for IoT, Cloud for IoT, Python web application framework Designing a restful web API		
		TOTAL: 45 PERIODS
TEXTBOOKS:		
1. Arshdeep Bahga and Vijay Madisetti, “Internet of Things - A Hands-on Approach”, Universities Press, 2015. 2. Kanagachidambaresan G R, “Role of Single Board Computers(SBCs) in Rapid IoT prototyping (Internet of things)”, Hardcover-Import, 2021.		
REFERENCE BOOKS:		
1. Matt Richardson & Shawn Wallace, O'Reilly, “Getting Started with Raspberry Pi”, 2014.		

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE109	**BIG DATA ANALYTICS**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Program Elective (Specialization)

PREAMBLE: To Understand, analyse and explore the concepts of big data management and its working principles to any technology environment, industry in establishes a baseline that can be enhanced by further formal training and additional real-world experience.

PREREQUISITE COURSES: Nil

RELATED COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES :

- To know the fundamental concepts of big data and analytics
- To explore tools and practices for working with big data
- To learn about stream computing
- To know about the research that requires the integration of large amounts of data

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 architecture and performance characteristics of big data systems and their analysis techniques.	K2
CO2	Apply clustering and classification algorithms to analyze data.	K3
CO3	Explain stream data models and their architectures.	K3
CO4	Apply data mining algorithms and recommendation systems to analyze large volumes of data.	K2
CO5	Develop NoSQL databases and implement database management techniques.	K3

CORRELATION OF COs AND POs

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

COURSE CONTENT :		
UNIT I	**BIG DATA INTRODUCTION**	**9**
Evolution of Big data -Big data characteristics and its Validating- Best Practices for Big data Analytics - The Promotion of the Value of Big Data - Big Data Use Cases- Characteristics of Big Data Applications - Perception and Quantification of Value -Understanding Big Data Storage - A General Overview of High Performance Architecture - HDFS – Map Reduce and YARN - Map Reduce Programming Model		
UNIT II	**CLUSTERING AND ITS TYPES**	**9**
Advanced Analytical Theory and Methods-Overview of Clustering and methods - K-means - Determining the Number of Clusters - Diagnostics - Classification: Decision Trees - Overview of a Decision Tree - The General Algorithm - Decision Tree Algorithms - Evaluating a Decision Tree - Decision Trees in R - Naïve Bayes - Bayes' Theorem - Naïve Bayes Classifier.		
UNIT III	**STREAM MEMORY**	**9**
Introduction to Streams Concepts – Stream Data Model and Architecture - Stream Computing, Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating moments – Counting oneness in a Window – Decaying Window – Real time Analytics Platform applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions. Using Graph Analytics for Big Data		
UNIT IV	**ASSOCIATION AND RECOMMENDATION SYSTEM**	**9**
Advanced Analytical Theory and Methods: Association Rules - Overview - Apriori Algorithm - Evaluation of Candidate Rules - Applications of Association Rules - Finding Association & finding similarity - Recommendation System: Collaborative - Content Based - Knowledge Based – Hybrid Recommendation Approaches		
UNIT V	**DATA MANAGEMENT FOR BIG DATA**	**9**
NoSQL Databases : Schema-less Models: Increasing Flexibility for Data Manipulation-Key Value Stores- Document Stores - Tabular Stores - Object Data Stores - Graph Databases Hive - Sharding – Hbase – Analyzing big data with twitter - Big data for E-Commerce Big data for blogs - Review of Basic Data Analytic Methods using R.		
		TOTAL: 45 PERIODS

TEXTBOOKS:

1. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.
2. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", Morgan Kaufmann/El sevier Publishers, 2013.

REFERENCE BOOKS:

1. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers, 2015.
2. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2015.
3. Dietmar Jannach and Markus Zanker, "Recommender Systems: An Introduction", Cambridge University Press, 2010.

COURSE CODE: **10212EE110**	COURSE TITLE: **CLOUD COMPUTING**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Elective (Specialization)

PREAMBLE: Design and development of cloud computing and its techniques in deploy for real time services and applications

PREREQUISITE COURSES: Nil

RELATED COURSES: NIL

COURSE EDUCATIONAL OBJECTIVES :

- To analyze the components of cloud computing and its business perspective.
- To evaluate the various cloud development tools.
- To collaborate with real time cloud services.
- To analyze the case studies to derive the best practice model to apply when developing and deploying cloud based 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	Develop cloud service delivery and deployment models.	K3
CO2	Explain various private cloud deployment models.	K2
CO3	Interpret the role of virtualization in cloud computing environments.	K2
CO4	Develop cloud service models for deployment in public cloud environments.	K3
CO5	Compare cloud security with traditional security approaches and relate them to emerging trends in cloud computing.	K2

CORRELATION OF COs AND POs

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

COURSE CONTENT :		
UNIT I	**CLOUD INTRODUCTION**	**9**
Cloud Computing basics, Types of cloud, Cloud services- Benefits and challenges of cloud computing, Evolution of Cloud Computing , usage scenarios and applications , Business models around Cloud – Major Players in Cloud Computing - Issues in Cloud - Eucalyptus - Nimbus – Open Nebula, CloudSim.		
UNIT II	**CLOUD COLLABORATION**	**9**
Collaborating on Calendars, Schedules and Task Management – Collaborating on Event Management, Contact Management, Project Management – Collaborating on Word Processing,Databases – Storing and Sharing Files- Collaborating via Web-Based Communication Tools – Evaluating Web Mail Services – Collaborating via Social Networks		
UNIT III	**SERVICES AND FILE SYSTEM FOR CLOUD**	**9**
Cloud services: Software - Platform– Infrastructure - Database – Monitoring- Communication as services. Service providers- Google App Engine, Amazon EC2, Microsoft Azure, Sales force. Introduction to Map Reduce, GFS, HDFS, Hadoop Framework.		
UNIT IV	**CLOUD VIRTUALIZATION**	**9**
Need for Virtualization –Types of Virtualization – System Vm, Process VM, Virtual Machine monitor – Virtual machine properties - Interpretation and binary translation, HLL VM - Hypervisors – Xen, KVM , VMWare, Virtual Box, Hyper-V, Cyber Security aspects in Virtualization.		
UNIT V	**SECURITY AND APPLICATIONS FOR CLOUD**	**9**
Cloud security challenges – Software as a Service Security, Common Standards: Open Cloud Consortium – Distributed management Task Force – Standards for application Developers – Messaging –Security and End user access to cloud computing, Mobile Internet devices		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Bloor R., Kanfman M., Halper F. Judith Hurwitz “Cloud Computing for Dummies” (Wiley India Edition), 2010.
2. John Rittinghouse & James Ransome, “Cloud Computing Implementation Management and Strategy”, CRC Press, 2010.

REFERENCE BOOKS:

1. Haley Beard, “Cloud Computing Best Practices for Managing and Measuring Processes for On-demand Computing”, Applications and Data Centers in the Cloud with SLAs, Emereo Pty Limited, 2008.
2. Antohy T Velte , “Cloud Computing :A Practical Approach”, McGraw Hill, 2009.

COURSE CODE:	COURSETITLE:	L	T	P	C
10212EE206	**DATA STRUCTURES AND ALGORITHMS USING C**	**2**	**0**	**2**	**3**

COURSE CATEGORY: Program Elective (Specialization)

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

PRE-REQUISITE COURSES:NIL

RELATED COURSES: Introduction to Design and Analysis of Algorithms, Database Management System, Operating Systems, and Computer Networks.

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.
- Implement various techniques of sorting and searching algorithms.

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 problem-solving strategies and asymptotic notations used in data representation and memory allocation.	K2
CO2	Apply linear data structures to solve real-world problems.	K3
CO3	Implement modular programs using nonlinear data structures and tree-manipulation algorithms for practical applications.	K3
CO4	Apply appropriate graph algorithms to solve graph-related problems.	K3
CO5	Apply sorting and searching techniques to solve real-world problems.	K3

CORRELATION OF COs AND POs

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:		
UNITI	**INTRODUCTION**	**6**
Introduction – The Problem Solving – Top down design Strategy – Algorithms vs Programs– Implementations of algorithms – Program Verification – The efficiency of algorithms – Algorithmic Notation – Asymptotic Notation– Analysis of Algorithms.		
UNIT II	**LINEAR DATA STRUCTURES**	**6**
Arrays: Allocation, Operations and Storage with one-dimensional arrays and multidimensional arrays. **Stacks:** Operations on Stacks, Applications of Stacks, **Queues:** Operations and its types. **Linked lists:** Operations and Types of linked list (singly, doubly and circularly linked list), Implementation of Stack and Queue using linked list, Applications of Linked List.		
UNIT III	**TREES AND HASHING**	6
Basic Tree Concepts – Binary Trees – Implementation – Tree Traversals – Applications – Binary Search Trees – AVL trees – Heaps. **Hashing:** Hash functions – collision handling – load factors, rehashing, and efficiency.		
UNIT IV	**GRAPHS**	**6**
Introduction to Graphs – Operations on graphs – Representation of Graph – Topological Sort - Graph Traversal - Depth first search – Breadth First Search – Minimum Spanning Tree – Prim‟s Algorithm - Kruskal‟s Algorithm –– Shortest Path Algorithms – Unweighted Shortest Paths –Dijkstra's Algorithm. Applications of Graphs.		
UNIT V	**SORTING AND SEARCHING**	**6**
Searching Techniques: Linear Search, Binary Search. **Sorting Techniques**: Insertion Sort, Selection sort, Merge sort, Quick Sort, Shell sort, Bubble sort, Bucket sort, Radix sort.		
		TOTAL: 30 PERIODS

TEXT BOOKS:

1. M. A. Weiss, "Data Structures and Algorithm Analysis in C", Second Edition, Pearson Education, Reprinted Edition 2013.
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson Freed, "Fundamentals of Data Structure in C", Universities Press, 2017.

REFERENCE BOOKS:

1. V. Aho, J. E. Hopcroft, and J. D. Ullman, "Data Structures and Algorithms", Pearson Education, First Edition, Reprint 2017.
2. R. F. Gilberg, B. A. Forouzan, "Data Structures", Second Edition, Thomson India Edition, 2007.
3. Seymour Lipschutz, "Data Structures with C", Scham's Outlines, Tata McGraw Hill, 2017.

ONLINE RESOURCES:

1. "Introduction to Data Structures and Algorithms" Accessed on 2009. https://nptel.ac.in/courses/106/102/106102064/.
2. "Data Structures and algorithms". Accessed on: Apr. 15, 2021.

https://www.coursera.org/specializations/data-structures-algorithms.
3. "Data structures Visualization" 2011.
https://www.cs.usfca.edu/~galles/visualization/Algorithms.html.
4. "Data Structures Fundamentals" 2021.
https://www.edx.org/course/data-structures-fundamentals

LIST OF EXPERIMENTS:

Task1: Array ADT
Using Array ADT perform the following:

i) Basic Operations in ADT: Creating an array, displaying of array elements, Inserting an element.

ii) Problems related to: Finding duplicates, missing element, minimum difference and rotations.

Task 2: Stack ADT
Develop and implement the following tasks using Stack ADT:

i) Stack using Array.

ii) Infix to Postfix Conversion.

iii) Tower of Hanoi.

Task 3: Queue ADT

Using Queue ADT perform the following:

i) Basic Operations of Queue ADT Using Array.

ii) Queue Implementation using Stack.

Task 4: Linked List

Design, Develop and Implement the following tasks using Linked List ADT.

i) Singly Linked List.

ii) Doubly Linked List.

iii) Circular Linked List.

Task 5: Sorting

Develop and implement the following sorting algorithms:

i) Insertion Sort.

ii) Merge Sort.

iii) Quick Sort.

iv) Bubble Sort.

v) Radix Sort.

Task 6: Searching

i) Implementation of Linear Search.

ii) Implementation of Binary Search.

Task 7: Binary search Tree

Design, Develop and Implement the following tasks using Binary search Tree.

i) Basic Operations of BST.

ii) Tree Traversal with Recursion.

iii) Tree Traversal without Recursion.

Task 8: Hashing

Using Hashing Technique perform the following:

i) Basic Hashing Technique.

ii) Linear Probing.

iii) Separate Chaining.

Task 9: Graph

Design, Develop and Implement the following tasks using Graph Concept.

i) Find the Shortest Path using Dijkstra's Algorithm.

ii) Find Minimum Spanning Tree using Prim's algorithm (based on Priority Queue).

iii) Find Minimum Spanning Tree using Kruskal's algorithm-using Disjoint subsets and Union find algorithm.

iv) Topological Sorting.

v) Graph Traversal using Depth First Search.

vi) Graph Traversal using Breadth First Search.

B.Tech. – Programme Specialization in Electric Vehicles

List of Courses for 18 Credits*

Sl.No.	Course Code	Course Name	L	T	P	C
1	10212EE111	Principles of EV Technology	3	0	0	3
2	10212EE112	EV Drives and Control	3	0	0	3
3	10212EE113	Energy Storage Systems	3	0	0	3
4	10212EE114	EV Charging Station	3	0	0	3
5	10212EE205	EV Modelling and Simulation	2	0	2	3
6	10212EE115	Hybrid Electric Vehicle Technologies	3	0	0	3
7	10212EE116	In-Vehicle Networking	3	0	0	3
8	10212EE117	Intelligent Vehicle Technology	3	0	0	3
9	10212EE118	Plug In Electric Vehicles in Smartgrid	3	0	0	3

*Students shall earn 3 credits under Program Electives category thro' NPTEL/SWAYAM.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE111	**PRINCIPLES OF EV TECHNOLOGY**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Program Elective

PREAMBLE: This course aims in providing the fundamental knowledge on electric vehicle technology and environmental advantages of electric vehicles.

PREREQUISITE COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Provide the basic fundamental knowledge on the electric vehicles and its architecture.
- Classify the architecture of different electric vehicles.
- Analyze various electric drives suitable for electric vehicles.
- Relate different energy storage technologies used and their control.

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 concepts and architecture of electric vehicle (EV) technology.	K2
CO2	Interpret the operating principles of different EV configurations and their components.	K2
CO3	Explain the applications of electric drive technologies in different types of EVs.	K2
CO4	Describe the role of energy storage devices in EV and hybrid electric vehicle technology.	K2
CO5	Explain various communication technologies used in electric vehicles.	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		L					L	M	M	
CO2	H			M		L					L	M	M	
CO3	M			M		M					L	M	M	
CO4	H			H		M					L	M	M	
CO5	H			H		L					L	M	M	

COURSE CONTENTS:

UNIT I	INTRODUCTION	9

Need for EV Technologies - comparison between IC engine and EV - overview of EVs and challenges - components of EVs - architecture of EVs - EV market and promotion-infrastructure needs - EV

makers - comparison in reference of: energy source, pollution, energy diversification, efficiency, capital & operating cost, performance.		
UNIT II	**CLASSIFICATIONS**	**9**
Classification of EVs - Configurations and block diagram: pure electric vehicles (PEV) - hybrid electric vehicles (HEV) and plug-in hybrid electric vehicles (PHEV) - battery electric vehicles (BEV) and fuel cell electric vehicles (FCEV).		
UNIT III	**EV DRIVES**	**9**
BEV, HEV and FCEV motor drive technologies - IC engine vehicle force - speed characteristics (5-gears), BEV force - speed characteristics (fixed gears) - comparison between ICE vehicles & BEV - requirement of EV motor compared to industrial motors.		
UNIT IV	**ENERGY STORAGE**	**9**
EV energy source technologies: energy sources used in EVs & HEVs - medium of power transfer (conductive and wireless) - wireless power transfer - Battery Management System (BMS).		
UNIT V	**EV COMMUNICATION**	**9**
Vehicle-to-Vehicle (V2V) and Vehicle-to-Grid (V2G): applications in power system - power saving & coordinated charging - layout of power converters for V2G operation - EV configurations: converted & purpose built EVs - components of EV communication system.		
TOTAL: 45 PERIODS		

TEXT BOOKS:

1. Hybrid Electric Vehicle System Modeling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.
2. T. Donateo, Ed., Hybrid Electric Vehicles. InTech, 2017.

REFERENCE BOOKS:

1. Electric and Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and the Market Gianfranco Pistoia Consultant, Rome, Italy, Elsevier Publications, 2017.
2. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Mehrdad Ehsani Yimin Gao Stefano Longo Kambiz M. Ebrahimi, Taylor & Francis Group, LLC, 2018.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE112	**EV DRIVES AND CONTROL**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

PREAMBLE: This course aims in providing a guide to control both AC and DC motors with a focus on its application to electric vehicle. Also, it provides various field oriented control and speed control.

PREREQUISITE COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Understand the requirement of EV motors.
- Analyze the Induction motor characteristics and speed control methods.
- Impart the knowledge on different electric motors operation and control.

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 need for electric motors in electric vehicles.	K2
CO2	Explain the suitability of different electric motors and their control techniques for EV applications.	K2
CO3	Illustrate speed control techniques for induction motors.	K2
CO4	Apply different control techniques to electric motor drives.	K2
CO5	Summarize the operating principles of switched reluctance motors (SRMs).	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 CONTENTS:

UNIT I	EV DRIVE MOTORS - INTRODUCTION	9

Drive system – requirements - challenges - comparisons of EV and industrial motors – drive motor characteristics - power ratings.

UNIT II	BRUSHLESS DC MOTOR DRIVE FOR EV	9

Brushless DC Motor (BLDC) – construction, principle of operation, speed control, characteristics and

configuration and control of BLDC motor drives.		
UNIT III	**INDUCTION MOTOR DRIVES FOR EV**	**9**
Induction motor – construction, principle of operation, speed control, characteristics and configuration and control of induction motor drives- sensor and sensorless control.		
UNIT IV	**SWITCHED RELUCTANCE MOTOR EV DRIVES**	**9**
Switched Reluctance Motor (SRM): construction, principle of operation, torque production -SRM drive converter - modes of operation - configuration and control of SRM motor drives.		
UNIT V	**PERMANENT MAGNET SYNCHRONOUS MOTOR DRIVES FOR EV**	**9**
Permanent magnet synchronous motor (PMSM) – construction, principle of operation, speed control, characteristics and configuration and control of PMSM motor drives.		
TOTAL: 45 PERIODS		
TEXT BOOKS:		
1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2010. 2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2009.		
REFERENCE BOOKS:		
1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.		

COURSE CODE: **10212EE113**	COURSE TITLE: **ENERGY STORAGE SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE CATEGORY: Programme Elective

PREAMBLE: This course provides a foundation for understanding the general principles and fundamentals of battery technology design, operation and management.

PREREQUISITE COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Understand the different types of energy storage system.
- Study about the battery characteristic & parameters.
- Know the concepts of battery management system and design the battery 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	Classify different energy storage systems.	K2
CO2	Describe the characteristics and parameters of batteries.	K2
CO3	Illustrate the models of different battery types.	K2
CO4	Apply battery management system concepts to design a battery energy storage system.	K2
CO5	Explain battery testing, disposal, and recycling methods.	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 CONTENTS:

UNIT I	**ENERGY STORAGE SYSTEM - INTRODUCTION**	**9**

Batteries: lead acid battery, 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.

UNIT II	**BATTERY CHARACTERISTICS**	**9**

Cells and Batteries- battery specifications: variables to characterize battery operating conditions and specifications-efficiency of batteries-electrical parameters- heat generation-performance criteria for electric vehicles batteries- vehicle propulsion factors- power and energy requirements of batteries.

UNIT III	BATTERY MODELLING	9
General approach to modelling batteries, modelling of Li-ion battery and NiCd battery, Parameterization of Li-ion and NiCd battery model.		
UNIT IV	**BATTERY MANAGEMENT SYSTEM**	**9**
Selection of battery for EVs & HEVs, traction battery pack design, requirement of battery monitoring, battery thermal management system, battery management system - power module, battery, DC/DC Converter, communication protocol. Battery Pack safety: Thermal runaway - high discharge rates, short circuits, charging and discharging explosions, causes of battery explosions, explosive process.		
UNIT V	**BATTERY TESTING, DISPOSAL AND RECYCLING**	**9**
Testing: chemical and structure material properties for cell safety and battery design, battery testing, limitations for transport and storage of cells and batteries. Disposal: disposal and second use of batteries, disposal policy. Recycling: general recycling issues and drivers, 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, Abul Masrur& David Wenzhong Gao, "Hybrid electric Vehicle- Principles & Applications with Practical Properties", Wiley, 2011.

REFERENCE BOOKS:

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric Hybrid Electric and Fuel Cell Vehicles", Taylor& Francis Group, 2010.
2. G. Pistoia, J.P. Wiaux, S.P. Wolsky, "Used Battery Collection and Recycling", Elsevier, 2001. (ISBN: 0-444-50562-8)

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE114	**EV CHARGING STATION**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Program Elective

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: Nil

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.
- Understand 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 EV charging station concepts, site selection criteria, and economic analysis.	K2
CO2	Explain equipment selection guidelines for designing EV charging stations.	K2
CO3	Summarize charging methods for electric vehicle batteries and hybrid energy storage systems.	K2
CO4	Enumerate the standards and integration challenges associated with EV charging stations.	K2
CO5	Explain the operating principles and applications of renewable energy-based EV 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	M	M	
CO5	H	M					M				L	M	M	

COURSE CONTENTS:

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	EV CHARGER COMPONENTS	9
Types of chargers - Selection of AC & DC chargers - AC & DC pile chargers –selection and sizing of distribution systems: 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 - 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 EV – wind charging stations – hybrid EV chargers - power rating selection – power electronic controllers - charging issues – future trends.		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001.

REFERENCE BOOKS:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained Wiley, 2003.
2. Amir Khajepour, Saber Fallah and Avesta Goodarzi, “Electric and Hybrid Vehicles Technologies, Modeling and Control: A Mechatronic Approach”, John Wiley & Sons Ltd, 2014.

COURSE CODE: 10212EE205	COURSE TITLE: EV MODELLING AND SIMULATION	L	T	P	C
		2	0	2	3

COURSE CATEGORY: Program Elective

PREAMBLE: This course aims in providing the knowledge on modelling and simulation of electric vehicle.

PREREQUISITE COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to,

- Impart fundamental knowledge on technical parameters of battery electric vehicles.
- Impart analytical knowledge on modelling and simulation of 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	Explain the technical parameters used in electric vehicle modelling.	K2,S2
CO2	Illustrate the modelling of battery electric vehicles.	K2,S2
CO3	Describe the characteristics of electric vehicle drivetrains.	K2,S2
CO4	Apply energy management system concepts in electric vehicles.	K2,S3
CO5	Explain vehicle dynamic control systems used in electric vehicles.	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	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 CONTENTS:

UNIT I	INTRODUCTION	6

Modeling performance parameters- tractive effort- rolling resistance force- aerodynamic drag- hill climbing force- acceleration force- total tractive effort- driving cycles- constant velocity range -

modeling vehicle acceleration: two, three and four wheelers.		
UNIT II	**MODELLING AND SIMULATION OF ELECTRIC VEHICLES**	**6**
Electric vehicle modelling - range modelling: battery electric vehicles, fuel cell vehicles and hybrid electric vehicles		
UNIT III	**DRIVE TRAIN CHARACTERISTICS**	**6**
Modelling and characteristics of EV power trains components - electric motor performance characteristics - battery performance characteristics-transmission and drive train characteristics		
UNIT IV	**ENERGY MANAGEMENT**	**6**
Simplified handling models for energy/power allocation and management - power/energy management controllers – control strategies – energy management control of electric vehicles.		
UNIT V	**EV DYNAMIC CONTROL**	**6**
Electric vehicle dynamics - fundamentals of vehicle dynamic control (VDC) systems - VDC implementation on electric vehicles.		
		TOTAL: 30 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.

LIST OF EXPERIMENTS: (30 PERIODS).

1. Develop a simulation model to analyze the effect of vehicle mass on vehicle range and performance.
2. Develop a simulation model to analyze the performance characteristics of BLDC motor.
3. Develop a simulation model to analyze the effect of Aerodynamic drag on vehicle range and performance.
4. Develop a simulation model for fuel cell electric vehicle.
5. Speed control of BLDC motor based electric vehicle.
6. Battery management system for electric vehicle applications.
7. Testing of battery charge controller.
8. Speed control of Hub motor based electric vehicle

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE115	**HYBRID ELECTRIC VEHICLE TECHNOLOGIES**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Program Elective (Specialization)

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

PREREQUISITE COURSES: Nil

RELATED COURSES: Nil

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 principles of vehicle propulsion and braking.	K2
CO2	Explain the structure and major components of an electric vehicle.	K2
CO3	Illustrate the operating principles of hybrid electric vehicles.	K2
CO4	Identify and solve problems associated with regenerative braking.	K3
CO5	Explain the environmental impacts of electric and hybrid vehicles.	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	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 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: 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. Emadi, Ali, “Handbook of Automotive Power Electronics and Motor Drives,” CRC press, 2005.
2. Soylu, Seref, “Electric Vehicles: The Benefits and Barriers,” In Tech, 2011.
3. Soylu, Seref, “Electric Vehicles–Modelling and Simulations," In Tech Europe, Rijeka, Croatia, 2011.

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE116	**IN-VEHICLE NETWORKING**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Program Elective (Specialization)

PREAMBLE: This course aims to provide the knowledge on communication network protocols involved in Electric Hybrid Vehicle.

PREREQUISITE COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are,

- To understand the basics of Vehicle networking
- To know the Different network communication protocols
- To obtain the broad analytical knowledge on Higher Layer Protocol, FlexRay protocol

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 in-vehicle networking concepts and architecture.	K2
CO2	Explain different in-vehicle networks and communication protocols.	K2
CO3	Explain higher-layer protocols used in in-vehicle networking.	K2
CO4	Describe the architecture and operating principles of the FlexRay protocol.	K2
CO5	Describe the diagnostic processes used in in-vehicle networking.	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									M	H	L
CO2	H	M	L									M	H	L
CO3	H	M	L									M	H	L
CO4	H	M	L									M	H	L
CO5	H	M	L									M	H	L

COURSE CONTENT:		
UNIT I	**BASICS OF IN-VEHICLE NETWORKING**	**9**
Overview of Data communication and networking –need for In-Vehicle networking – layers of OSI reference model –multiplexing and de- multiplexing concepts –vehicle buses		
UNIT II	**NETWORKS AND PROTOCOLS**	**9**
Overview of general-purpose networks and protocols -Ethernet, TCP, UDP, IP,ARP,RARP, Wi-Fi – LIN standard overview –workflow concept-applications –LIN protocol specification –signals - Frame transfer–Frame types –Schedule tables –Task behaviour model –Network management – status management.		
UNIT III	**HIGHER LAYER PROTOCOL**	**9**
Introduction to CAN open –TTCAN –Device net -SAE J1939 - overview of data channels – Control channel-synchronous channel – asynchronous channel –Logical device model – functions-methods-properties-protocol basics- Network section-data transport –Blocks – frames –Preamble-boundary descriptor.		
UNIT IV	**FLEXRAY PROTOCOL**	**9**
Introduction –network topology –ECUs and bus interfaces –controller host interface and protocol operation controls –media access control and frame and symbol processing – coding/decoding unit –FlexRay scheduling		
UNIT V	**IN VEHICLE NETWORK DIAGNOSTICS**	**9**
Process of Automotive Fault Diagnostics, Fault Codes, Vehicle Systems (open-loop and closed-loop) On- and Off- Board Diagnostics, OBD-I, OBD-II, Engine Analyzers, Steps taken to diagnose a fault, Diagnostics Protocol-KWP2000, SAE-J1587, SAE-J1708 and Case Study		
		TOTAL: 45 PERIODS

TEXT BOOKS:

1. J. Gabrielleen,"Automotive In-Vehicle Networks", John Wiley & Sons, Limited, 2008.
2. Robert Bosch," Bosch Automotive Networking", Bentley Publishers, 2007.

REFERENCE BOOKS:

1. Ronald K. Jurgen, "Automotive Electronics Handbook," McGraw-Hill, 1999.
2. Indra Widjaja, Alberto Leon-Garcia, "Communication Networks: Fundamental Concepts and Key Architectures", McGraw-Hill College; 1st Edition, 2000.
3. Olaf Pfeiffer, Andrew Ayre, Christian Keydel, "Embedded Networking with CAN and CANopen", Anna books/RTC Books, 2003.

COURSE CODE: **10212EE117**	COURSE TITLE: **INTELLIGENT VEHICLE TECHNOLOGY**	L	T	P	C
		3	**0**	**0**	**3**

COURSE CATEGORY: Program Elective (Specialization)

PREAMBLE: In this course student will get exposure to Intelligent Vision System in automobiles, Architecture of Intelligent Transportation System and adaptive control techniques of an autonomous vehicle.

PREREQUISITE COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- Acquire knowledge of about Intelligent vision system
- Know the architecture of Intelligent transportation system
- Impart the techniques of adaptive control
- Know the architecture for autonomous vehicles
- Study the autonomous vehicle cases

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	Illustrate intelligent vision systems used in automobiles.	K2
CO2	Explain the architecture of intelligent transportation systems.	K2
CO3	Explain adaptive control techniques used in autonomous vehicles.	K2
CO4	Summarize successful autonomous vehicle projects.	K2
CO5	Outline case studies of autonomous vehicles and their applications.	K2

CORRELATION OF COs AND POs

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

COURSE CONTENT:		
UNIT I	**INTRODUCTION TO INTELLIGENT VISION SYSTEM**	**9**
Vision Based Driver–Vehicle optical Sensor Laser Radar- Non Contact ground velocity detecting Sensor - Road Surface Recognition Sensor- Vehicle Sensors for Electronic Toll Collection System- Components of a Vision Sensor System- Driver Assistance on Highways –Lane Recognition		
UNIT II	**VEHICLE INFORMATION SYSTEM AND INTELLIGENT TRANSPORTATION**	**9**
Intelligent Transportation System (ITS) – Vision for ITS Communications- Multimedia communication in a car - Current ITS Communication Systems and Services - Vehicle to Vehicle Communication systems-Road to Vehicle communication systems-Inter Vehicle communication - VANETS-Devices-		
UNIT III	**ADAPTIVE CONTROL FOR ELECTRIC VEHICLES**	**9**
Automatic Control Of Highway Traffic And Moving Vehicles - Adaptive Control Overview - Gain Scheduling - Model Reference Adaptive Control-Self-Tuning Adaptive Control System Model		
UNIT IV	**ARCHITECTURES FOR AUTONOMOUS VEHICLES**	**9**
Control Architectures - Motion Autonomy - Deliberative Architectures- Reactive Architectures- Hybrid Architecture Overview- Hybrid Architecture Examples- Overview of Sharp Architecture - Models Of Vehicles - Concepts of Sensor Based Maneuver.		
UNIT V	**AUTONOMOUS VEHICLE**	**9**
ARGO Prototype Vehicle - Gold System - Inverse Perspective Mapping - Lane Detection- Obstacle Detection -Vehicle Detection- Pedestrian Detection - Software systems architecture - Computational Performances.		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. LjuboVlacic, Michel Parent and Fumio Harashima,"Intelligent Vehicle Technologies," Butterworth-Heinemann publications, Oxford, 2001.		
REFERENCE BOOKS:		
1. Ronald K Jurgen, "Automotive Electronics Handbook," Automotive Electronics Series, SAE, USA, 1998. 2. Nicu Bizon,Lucian D Ascalescu and Naser Mahdavit Abatabaei "Autonomous Vehicles - Intelligent Transport Systems and Smart Technologies, 2014.		

COURSE CODE:	COURSE TITLE:	L	T	P	C
10212EE118	**PLUG-IN ELECTRIC VEHICLES IN SMARTGRID**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Program Elective (Specialization)

PREAMBLE: This course aimed to provide the basics of Electric Vehicle on Smart Grid System.

PREREQUISITE COURSES: Nil

COURSE EDUCATIONAL OBJECTIVES:

The objectives of the course are to make the students,

- Understand the plug in electric vehicle technologies.
- Understand the Wireless power Transfer (WPT) methods for Electric Vehicles.
- Gain knowledge on PEV battery technologies and its modelling.
- Familiar with capacity planning for large scale PEV charging station.

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 plug-in electric vehicle (PEV) technologies and their integration with the electric grid.	K2
CO2	Explain wireless power transfer methods used for electric vehicle charging.	K2
CO3	Describe PEV battery technologies and associated servicing equipment.	K2
CO4	Illustrate PEV battery modelling techniques and approaches.	K2
CO5	Explain storage capacity planning for large-scale PEV charging stations.	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	H	L
CO2	H	M									L	L	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	OVERVIEW OF SMARTGRID	9

Evolution of Smart Grid. Need and Benefits of Smart Grid. Divers for Smart grid, functions, opportunities and challenges. Difference between conventional and Smart Grid. Concept of Resilient & Self-Healing Grid, Present development & International policies in Smart Grid. Smart Grid

Technology Drivers, Renewable energy resources		
UNIT II	**PLUG-IN ELECTRIC VEHICLE**	**9**
Introduction of Plug-in Electric Vehicle (PEV)-PEV Technologies-PEV System-Technical Issues in PEV-Smart Charging Infrastructure-Integration of PEVs to electric grid. Introduction of Wireless Power Transfer (WPT)-Basics of WPT Technologies-Wireless energy Transfer Methods-Modeling the WPT system.		
UNIT III	**PEV BATTERY TECHNOLOGIES AND COST MODELS**	**9**
Battery Technologies-Plug in EV Drive Train Architecture-Electric vehicle service equipment. Battery Degradation Cost-PEV Battery Modelling-Modeling Approach I and II-Electricity Cost-Case Study.		
UNIT IV	**CAPACITY PLANNING FOR LARGE SCALE PEV CHARGING STATION**	**9**
Charging station Model-System Description-Storage capacity analysis for single class PEVs-Storage capacity analysis for multi class PEVs.		
UNIT V	**EV INTEGRATION IN SMARTGRID**	**9**
Vehicle-to-grid (V2G) technology, demand response management, optimal charging strategies, grid stability impacts, integration with renewable energy sources, communication protocols for charging stations,		
		TOTAL: 45 PERIODS
TEXT BOOKS:		
1. Islam Safak Bayram, Ali Tejar "Plug in Electric Vehicle Integration," Artech House Boston/London, 2017.		
REFERENCE BOOK:		
1. Junwei Lu and Jahangir Hossain, "Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid," IET 2015. 2. Lance Noel, Gerardo Zarazua de Rubens Johannes Kester, Benjamin K. Sovacool, "Vehicle-to-Grid A Sociotechnical Transition Beyond Electric Mobility," 2019.		

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	3	0	0	3

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

COURSE CATEGORY: Open Elective (Minor degree)

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: Nil

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 EV charging station concepts, site selection criteria, and economic analysis.	K2
CO2	Explain equipment selection guidelines for designing EV charging stations.	K2
CO3	Summarize charging methods for electric vehicle batteries and hybrid energy storage systems.	K2
CO4	Explain the standards and integration issues associated with EV charging stations.	K2
CO5	Explain the operating principles and applications of renewable energy-based EV 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 CONTENTS:

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:

3. Sukhatme S P and Nayak J K, 'Solar Energy - Principles of Thermal Collection and Storage', Tata McGraw Hill, 2008.
4. Frank Kreith and Yogi Goswami D, 'Handbook of Energy Efficiency and Renewable Energy', CRC Press, 2007.
5. Wakil M M H, "Power Plant Technology", McGraw Hill, 1984.
6. 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: Open Elective (Minor degree)

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

PREREQUISITE COURSES: Nil

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 suitable battery management system (BMS) for a given battery type and application.	K2
CO2	Estimate the state of charge (SoC), deliverable voltage and power, state of health (SoH), and remaining useful life of a battery using appropriate methods.	K3
CO3	Solve problems related to cell-voltage balancing in battery systems.	K3
CO4	Describe battery safety aspects and thermal management concepts.	K2
CO5	Explain battery testing methods and the disposal and recycling issues associated with 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 CONTENTS:		
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: Open Elective (Minor degree)

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: Nil

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 requirements of electric motors in electric vehicles.	K2
CO2	Explain the suitability of different electric motors and their control techniques for EV applications.	K2
CO3	Illustrate speed control techniques for induction motors.	K2
CO4	Outline pulse-width modulation (PWM) techniques used in inverters for induction motor control.	K2
CO5	Summarize different motor sensors and sensorless motor operation techniques.	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 CONTENTS:

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: Open Elective (Minor degree)

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

PREREQUISITE COURSES: Nil

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	Explain the principle of vehicle propulsion and braking.	K2
CO2	Explain the structure and major components of an electric vehicle.	K2
CO3	Illustrate the working principle of a Hybrid Electric Vehicle.	K2
CO4	Identify and solve problems associated with regenerative braking.	K3
CO5	Explain the environmental impacts of electric and hybrid vehicles.	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 CONTENTS:

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: Open Elective (Minor degree)

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: Nil

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	Explain the different types of energy storage systems.	K2
CO2	Describe battery characteristics and parameters.	K2
CO3	Apply battery management system concepts to design a battery pack.	K3
CO4	Summarize the different types of batteries.	K2
CO5	Explain battery testing, disposal, and recycling methods.	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 CONTENTS:

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**	**3**	**0**	**0**	**3**

COURSE CATEGORY: Open Elective (Minor degree)

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

PREREQUISITE COURSES: Nil

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	Explain the technical parameters of batteries.	K2
CO2	Compare different types of batteries used in EV applications.	K2
CO3	Design a battery charger for an electric vehicle.	K2
CO4	Interpret the applications of supercapacitors in suitable energy storage systems.	K2
CO5	Classify different 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 CONTENTS:

UNIT I	MODELLING OF VEHICLE PERFORMANCE PARAMETER	9

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	9
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**	**9**
Modelling and Characteristics of EV Power trains Components - Electric Motor Performance Characteristics - Battery Performance Characteristics-Transmission and Drive train Characteristics		
UNIT IV	**ENERGY MANAGEMENT**	**9**
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: 45 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	10213EE202	Solar Photovoltaics: Fundamentals, Technology and Applications (Integrated)	2	0	2	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: Open Elective (Minor degree)

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: Nil

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	Explain 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 CONTENTS:		
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: Open Elective (Minor degree)

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

PREREQUISITE COURSES: Nil

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	Explain the fundamentals of wind energy conversion.	K2
CO2	Explain the types of wind turbines and their aerodynamic principles.	K2
CO3	Explain the components and construction of wind turbines.	K2
CO4	Explain the operating principles of different types of generators used in wind energy systems.	K2
CO5	Explain the control and monitoring systems used in wind turbines.	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 CONTENTS:		
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: **10213EE202**	COURSE TITLE: **SOLAR PHOTOVOLTAICS: FUNDAMENTALS, TECHNOLOGY AND APPLICATIONS**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

COURSE CATEGORY: Open Elective - Integrated (Minor degree)

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: Nil

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	Explain the principle of direct solar energy conversion into electrical power using photovoltaic (PV) systems.	K2
CO2	Compare the performance parameters of photovoltaic systems.	K2
CO3	Explain the types of solar cells and the design aspects of solar PV systems.	K2
CO4	Identify the components of PV systems and construct basic solar PV systems.	K3
CO5	Explain the applications of solar PV systems and the 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 (30 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.

ONLINE 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: Open Elective (Minor degree)

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	Explain the fundamentals of energy conservation technologies.	K2
CO2	Explain the principles and operation of waste heat recovery systems.	K2
CO3	Explain methods for improving energy efficiency in buildings.	K2
CO4	Explain the key provisions of the Energy Conservation Act.	K2
CO5	Explain renewable energy generation systems used 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 CONTENTS:		
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: Open Elective (Minor degree)

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: Nil

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	Explain the different types of solar thermal energy conversion systems.	K2
CO2	Explain the working principles of solar thermal collectors and their performance parameters.	K2
CO3	Explain the different solar thermal energy storage systems.	K2
CO4	Explain the practical applications of solar thermal energy.	K2
CO5	Explain the cost estimation and installation-related issues of solar thermal energy conversion systems.	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 CONTENTS:		
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: Open Elective (Minor degree)

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: Nil

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	Explain distributed and grid-connected energy generation systems.	K2
CO2	Explain the working principles of turbine generators used with different renewable energy sources.	K2
CO3	Explain distributed generation systems and the equipment required for their implementation.	K2
CO4	Explain renewable energy grid integration and the associated challenges.	K2
CO5	Explain the integration of multiple renewable energy sources with the electrical grid through hybrid systems.	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 CONTENTS:		
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

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

COURSE CATEGORY: Programme Elective (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: Nil

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	Explain the need for smart grid technology and the characteristics of the transmission grid.	K2
CO2	Describe communication technologies used in smart grids.	K2
CO3	Illustrate the roles of smart meters and sensors in smart grids.	K2
CO4	Explain power quality measurement techniques used in smart grids.	K2
CO5	Explain the roles of renewable energy storage systems and electric vehicles in smart grids.	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 CONTENTS:

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

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

COURSE CATEGORY: Programme Elective (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: Nil

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	Explain the functions of energy management and the energy audit process.	K2
CO2	Explain the principles of economic analysis applied to energy systems.	K2
CO3	Explain energy conservation options in lighting and lighting control systems.	K2
CO4	Explain the importance and functional requirements of SCADA systems.	K2
CO5	Explain SCADA applications and wide-area protection 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		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 CONTENTS:

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

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

COURSE CATEGORY: Programme Elective (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: Nil

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	Explain the concept of electricity deregulation and the roles of different entities in the electricity market.	K2
CO2	Explain electricity market structures and bidding mechanisms.	K2
CO3	Explain transmission pricing methods and ancillary services.	K2
CO4	Explain the management of ancillary services in deregulated electricity markets.	K2
CO5	Explain the technical challenges associated with power system 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 CONTENTS:

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.

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

COURSE CATEGORY: Programme Elective (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: Nil

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	Explain the need for optimal siting and sizing of distributed generation (DG) and its effects on distribution systems.	K2
CO2	Explain grid integration requirements and applicable standards.	K2
CO3	Explain the stability and power quality issues associated with distributed generation.	K2
CO4	Explain the configurations and structures of AC and DC microgrids.	K2
CO5	Describe the operational principles and control concepts of microgrids.	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 CONTENTS:		
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

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

COURSE CATEGORY: Programme Elective (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: Nil

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 the Internet of Things (IoT) and smart grids.	K2
CO2	Explain IoT technologies and communication technologies used in smart grids.	K2
CO3	Explain the applications of Home Area Networks (HANs), Neighbourhood Area Networks (NANs), and Wide Area Networks (WANs).	K2
CO4	Explain suitable architectures for IoT-enabled smart grid systems.	K2
CO5	Enumerate suitable architectures, potential applications, and existing prototypes of IoT-enabled 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 CONTENTS:		
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 AND COMMUNICATION 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	**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 IV	**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.		
UNIT V	**APPLICATIONS OF IoT AIDED 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.		
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.

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

COURSE CATEGORY: Programme Elective (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: Nil

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	Explain the fundamental concepts of Artificial Intelligence (AI).	K2
CO2	Explain AI technologies and their applications in solving real-world problems.	K2
CO3	Describe pattern recognition techniques and their applications.	K2
CO4	Explain artificial neural networks and different learning methods.	K2
CO5	Enumerate potential applications and existing prototypes of AI-enabled 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 CONTENTS:

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.