

# **B.E (Electrical and Electronics Engineering)**

## **Revised 2018 Regulations, Curriculum & Syllabi**



### **BANNARI AMMAN INSTITUTE OF TECHNOLOGY**

An Autonomous Institution Affiliated to Anna University - Chennai • Approved by AICTE • Accredited by NAAC with "A+" Grade

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## **VISION OF THE DEPARTMENT**

- To offer world-class education, by providing Academic and Professional competence in tune with technological and societal aspirations.

## **MISSION OF THE DEPARTMENT**

- To produce globally competent Electrical and Electronics Engineers through continuously evolving teaching and learning process.
- To promote the knowledge and skills of students, members of faculty and supporting staff through professional training.
- To induce the young minds of engineers to meet the expectations of industry and society.

## **PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)**

**On successful completion of four year BE degree programme quite a few years after graduation our graduates will**

PEO1: Apply, analyze, design and create products and solutions for real-life Electrical and Electronics Engineering problems.

PEO2: Function effectively in multidisciplinary teams with technical competency to develop sustainable solutions for global, environmental and societal needs in an ethical way.

PEO3: Update their domain knowledge to attain continuous career enhancement / to be an entrepreneur and to adapt themselves to life-long learning.

## PROGRAMME OUTCOMES (POs)

### Engineering Graduates will be able to:

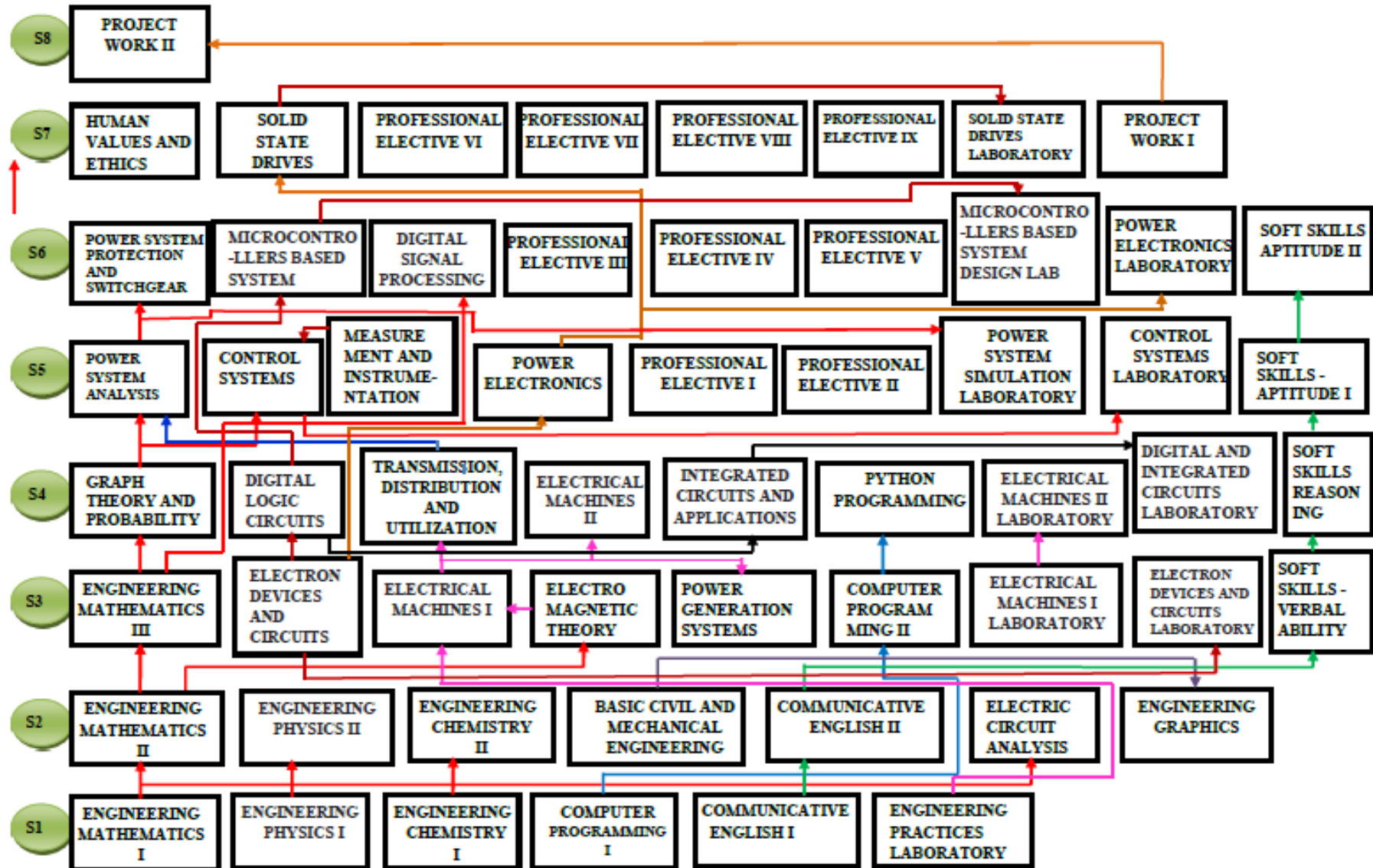
- a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
- c. **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.
- d. **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.
- e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- f. **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.
- g. **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.
- h. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- i. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- j. **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.
- k. **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.
- l. **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## **PROGRAMME SPECIFIC OUTCOMES (PSOs)**

1. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
2. Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

### MAPPING OF PEOs and POs

POs	a	b	c	d	e	f	g	h	i	j	k	l
PEO1	X	X	X	X	X		X	X	X	X		X
PEO2	X		X	X	X	X		X	X	X	X	
PEO3	X	X		X		X	X				X	X



**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**  
**R2018 (Revised Curriculum)**  
**Minimum Credits to be earned: 162**

<b>I SEMESTER</b>										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
18EE101	ENGINEERING MATHEMATICS I	3	1	0	4	4	40	60	100	BS
18EE102	ENGINEERING PHYSICS I	2	0	2	3	4	50	50	100	BS
18EE103	ENGINEERING CHEMISTRY I	2	0	2	3	4	50	50	100	BS
18EE104	COMPUTER PROGRAMMING I	2	0	2	3	4	50	50	100	ES
18HS101	COMMUNICATIVE ENGLISH I	1	0	2	2	3	100	0	100	HS
18EE106	ENGINEERING PRACTICES LABORATORY	0	0	4	2	4	100	0	100	ES
<b>Total</b>		<b>10</b>	<b>1</b>	<b>12</b>	<b>17</b>	<b>23</b>	-	-	-	-
<b>II SEMESTER</b>										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
18EE201	ENGINEERING MATHEMATICS II	3	1	0	4	4	40	60	100	BS
18EE202	ENGINEERING PHYSICS II	2	0	2	3	4	50	50	100	BS
18EE203	ENGINEERING CHEMISTRY II	2	0	2	3	4	50	50	100	BS
18EE204	BASIC CIVIL AND MECHANICAL ENGINEERING	3	0	0	3	3	40	60	100	ES
	LANGUAGE ELECTIVE	-	-	-	2	2	100	0	100	HS
18EE206	ELECTRIC CIRCUIT ANALYSIS	3	0	2	4	5	50	50	100	ES
18EE207	ENGINEERING GRAPHICS	1	0	4	3	5	100	0	100	ES
<b>Total</b>		<b>14</b>	<b>1</b>	<b>10</b>	<b>22</b>	<b>27</b>	-	-	-	-

III SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
18EE301	ENGINEERING MATHEMATICS III	3	1	0	4	4	40	60	100	BS
18EE302	ELECTRON DEVICES AND CIRCUITS	3	0	0	3	3	40	60	100	PC
18EE303	ELECTRICAL MACHINES I	3	1	0	4	4	40	60	100	PC
18EE304	ELECTROMAGNETIC THEORY	3	1	0	4	4	40	60	100	ES
18EE305	POWER GENERATION SYSTEMS	3	0	0	3	3	40	60	100	PC
18EE306	COMPUTER PROGRAMMING II	3	0	2	4	5	50	50	100	ES
18EE307	ELECTRICAL MACHINES I LABORATORY	0	0	2	1	2	100	0	100	PC
18EE308	ELECTRON DEVICES AND CIRCUITS LABORATORY	0	0	2	1	2	100	0	100	PC
18GE301	SOFT SKILLS - VERBALABILITY	0	0	2	-	2	100	0	100	EEC
<b>Total</b>		<b>18</b>	<b>3</b>	<b>8</b>	<b>24</b>	<b>29</b>	-	-	-	-
IV SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
18EE401	GRAPH THEORY AND PROBABILITY	3	1	0	4	4	40	60	100	BS
18EE402	DIGITAL LOGIC CIRCUITS	3	1	0	4	4	40	60	100	PC
18EE403	TRANSMISSION , DISTRIBUTION AND UTILIZATION	3	0	0	3	3	40	60	100	PC
18EE404	ELECTRICAL MACHINES II	3	1	0	4	4	40	60	100	PC
18EE405	INTEGRATED CIRCUITS AND APPLICATIONS	3	0	0	3	3	40	60	100	PC
18EE406	PYTHON PROGRAMMING	2	0	2	3	4	50	50	100	ES
18EE407	ELECTRICAL MACHINES II LABORATORY	0	0	2	1	2	100	0	100	PC
18EE408	DIGITAL AND INTEGRATED CIRCUITS LABORATORY	0	0	2	1	2	100	0	100	PC
18HS001	ENVIRONMENTAL SCIENCE	2	0	0	-	2	100	0	100	HS
18GE401	SOFT SKILLS – BUSINESS ENGLISH	0	0	2	-	2	100	0	100	EEC
<b>Total</b>		<b>19</b>	<b>3</b>	<b>8</b>	<b>23</b>	<b>30</b>	-	-	-	-

V SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
21EE501	POWER SYSTEM ANALYSIS	3	1	0	4	4	40	60	100	PC
21EE502	CONTROL SYSTEMS	3	1	0	4	4	40	60	100	PC
21EE503	MEASUREMENT AND INSTRUMENTATION	3	0	2	4	5	50	50	100	PC
21EE504	POWER ELECTRONICS	3	1	0	4	4	40	60	100	PC
	PROFESSIONAL ELECTIVE I	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE II	3	0	0	3	3	40	60	100	PE
21EE507	POWER SYSTEM SIMULATION LABORATORY	0	0	2	1	2	100	0	100	PC
21EE508	CONTROL SYSTEMS LABORATORY	0	0	2	1	2	100	0	100	PC
18GE501	SOFT SKILLS - APTITUDE I	0	0	2	-	2	100	0	100	EEC
<b>Total</b>		<b>18</b>	<b>3</b>	<b>8</b>	<b>24</b>	<b>29</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
VI SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
21EE601	POWER SYSTEM PROTECTION AND SWITCHGEAR	3	1	0	4	4	40	60	100	PC
21EE602	MICROCONTROLLERS BASED SYSTEM DESIGN	3	0	0	3	3	40	60	100	PC
21EE603	DIGITAL SIGNAL PROCESSING	3	1	0	4	4	40	60	100	PC
	PROFESSIONAL ELECTIVE III	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE IV	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE V	3	0	0	3	3	40	60	100	PE
21EE607	MICROCONTROLLERS BASED SYSTEM DESIGN LAB	0	0	2	1	2	100	0	100	PC
21EE608	POWER ELECTRONICS LABORATORY	0	0	2	1	2	100	0	100	PC
18GE601	SOFT SKILLS - APTITUDE II	0	0	2	-	2	100	0	100	EEC
<b>Total</b>		<b>18</b>	<b>2</b>	<b>6</b>	<b>22</b>	<b>26</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

<b>VII SEMESTER</b>										
<b>Code No.</b>	<b>Course</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>Hours/Week</b>	<b>Maximum Marks</b>			<b>Category</b>
							<b>CA</b>	<b>ES</b>	<b>Total</b>	
21HS002	HUMAN VALUES AND ETHICS	2	0	0	2	2	40	60	100	HSS
21EE702	SOLID STATE DRIVES	3	0	0	3	3	40	60	100	PC
	PROFESSIONAL ELECTIVE VI	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE VII	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE VIII	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE IX	3	0	0	3	3	40	60	100	PE
21EE707	SOLID STATE DRIVES LABORATORY	0	0	2	1	2	60	40	100	PC
21EE708	PROJECT WORK I	0	0	6	3	6	60	40	100	EEC
<b>Total</b>		<b>17</b>	<b>0</b>	<b>8</b>	<b>21</b>	<b>25</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>VIII SEMESTER</b>										
<b>Code No.</b>	<b>Course</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>Hours/Week</b>	<b>Maximum Marks</b>			<b>Category</b>
							<b>CA</b>	<b>ES</b>	<b>Total</b>	
21EE804	PROJECT WORK II	0	0	18	9	18	50	50	100	EEC
<b>Total</b>		<b>0</b>	<b>0</b>	<b>18</b>	<b>9</b>	<b>18</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

<b>ELECTIVES</b>										
<b>LANGUAGE ELECTIVES</b>										
Code No.	Course	L	T	P	C	Hours /Week	Maximum Marks			Category
							CA	ES	Total	
18HS201	COMMUNICATIVE ENGLISH II	1	0	2	2	3	100	0	100	HSS
18HSH01	HINDI	1	0	2	2	3	100	0	100	HSS
18HSF01	FRENCH	1	0	2	2	3	100	0	100	HSS
18HSG01	GERMAN	1	0	2	2	3	100	0	100	HSS
18HSC01	CHINESE	1	0	2	2	3	100	0	100	HSS
18HSJ01	JAPANESE	1	0	2	2	3	100	0	100	HSS
<b>ONE CREDIT COURSES</b>										
18EE0XA	EMBEDDED CONTROL OF ELECTRIC DRIVES	1	0	0	1	1	100	0	100	OC
18EE0XB	DESIGN OF EMBEDDED SYSTEM FOR DC MOTOR	1	0	0	1	1	100	0	100	OC
18EE0XC	INDUSTRIAL AUTOMATION	1	0	0	1	1	100	0	100	OC
18EE0XD	QUALITY MANAGEMENT SYSTEM	1	0	0	1	1	100	0	100	OC
18EE0XE	PRODUCT LIFECYCLE MANAGEMENT	1	0	0	1	1	100	0	100	OC
18EE0XF	APPLICATIONS OF SYNCHRONOUS GENERATOR IN INDUSTRIES	1	0	0	1	1	100	0	100	OC
18EE0XG	REACTIVE POWER MANAGEMENT AND ENERGY STORAGE DEVICES	1	0	0	1	1	100	0	100	OC
18EE0XH	SUBSTATION DESIGN	1	0	0	1	1	100	0	100	OC
18EE0XI	DESIGN OF GRID TIED SOLAR PV SYSTEM	1	0	0	1	1	100	0	100	OC
18EE0XJ	DESIGN OF INDOOR AND OUTDOOR LIGHTING USING DIALUX	1	0	0	1	1	100	0	100	OC
18EE0XK	DESIGN OF POWER CONVERTERS FOR INDUSTRIAL APPLICATIONS	1	0	0	1	1	100	0	100	OC
18EE0XL	LITHIUM BATTERY TECHNOLOGY FOR EV	1	0	0	1	1	100	0	100	OC
18EE0XM	POWER PLANT AUTOMATION USING SCADA AND DCS	1	0	0	1	1	100	0	100	OC
18EE0XN	POWER SYSTEMS DESIGN AND ANALYSIS USING ETAP	1	0	0	1	1	100	0	100	OC
<b>ADDITIONAL ONE CREDIT COURSES</b>										
18GE0XA	ETYMOLOGY	1	0	0	1	1	100	0	100	-
18GE0XB	GENERAL PSYCHOLOGY	1	0	0	1	1	100	0	100	-

18GE0XC	NEURO BEHAVIOURAL SCIENCE	1	0	0	1	1	100	0	100	-
18GE0XD	VISUAL MEDIA AND FILM MAKING	1	0	0	1	1	100	0	100	-
18GE0XE	YOGA FOR HUMAN EXCELLANCE	1	0	0	1	1	100	0	100	-
18GE0XF	VEDIC MATHEMATICS	1	0	0	1	1	100	0	100	-
18GE0XG	ABNORMAL PSYCHOLOGY	1	0	0	1	1	100	0	100	-
18GE0XH	YOGA FOR ENERGETIC LIFE	1	0	0	1	1	100	0	100	-
18GE0XI	BLOG WRITING	1	0	0	1	1	100	0	100	-
18GE0XJ	INTERPERSONAL SKILLS	1	0	0	1	1	100	0	100	-
18GE0XK	COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT	1	0	0	1	1	100	0	100	-
18GE0XL	NATIONAL CADET CORPS	1	0	0	1	1	100	0	100	-
18GE0XM	NEW AGE INNOVATION AND ENTREPRENEURSHIP	1	0	0	1	1	100	0	100	-
18GE0XN	DISRUPTIVE INNOVATION BASED STARTUP ACTIVITIES	1	0	0	1	1	100	0	100	-
18GE0XO	SOCIAL PSYCHOLOGY	1	0	0	1	1	100	0	100	-
18GE0XP	FM RADIO BROADCASTING TECHNOLOGY	1	0	0	1	1	100	0	100	-
<b>VALUE ADDED COURSES</b>										
18EEV01	ORCAD									
18EEV02	HANDS ON TRAINING ON DESIGN OF CONTROLLERS FOR POWER CONVERTERS									
18EEV03	IOT BASED SYSTEM DESIGN									
18EEV04	ELECTRONIC CIRCUIT DESIGN									
18EEV05	COMPUTER AIDED DESIGN AND ANALYSIS OF ELECTRICAL SYSTEM									
18EEV06	DESIGN OF POWER CONVERTERS FOR ELECTRICAL MACHINES									
18EEV07	INDUSTRIAL CONTROL									
18EEV08	ANALOG AND DIGITAL CIRCUIT DESIGN									

<b>PROFESSIONAL ELECTIVES</b>										
<b>VERTICAL I - POWER SYSTEMS</b>										
21EE001	POWER SYSTEM OPERATION AND CONTROL	3	0	0	3	3	40	60	100	PE
21EE002	POWER QUALITY	3	0	0	3	3	40	60	100	PE
21EE003	HIGH VOLTAGE TRANSMISSION	3	0	0	3	3	40	60	100	PE
21EE004	DEMAND SIDE MANAGEMENT	3	0	0	3	3	40	60	100	PE
21EE005	SMART GRID TECHNOLOGIES	3	0	0	3	3	40	60	100	PE
21EE006	POWER SYSTEM	3	0	0	3	3	40	60	100	PE
<b>VERTICAL II - POWER ELECTRONICS AND DRIVES</b>										
21EE007	ADVANCED POWER SEMICONDUCTOR	3	0	0	3	3	40	60	100	PE
21EE008	ADVANCED POWER CONVERTERS	3	0	0	3	3	40	60	100	PE
21EE009	MODERN RECTIFIERS AND RESONANT	3	0	0	3	3	40	60	100	PE
21EE010	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	3	0	0	3	3	40	60	100	PE
21EE011	ELECTRIC DRIVES AND CONTROL	3	0	0	3	3	40	60	100	PE
21EE012	POWER ELECTRONIC INTERFACES FOR RENEWABLE ENERGY SOURCES	3	0	0	3	3	40	60	100	PE
<b>VERTICAL III - ELECTRIC VEHICLE TECHNOLOGY</b>										
21EE013	ELECTRIC VEHICLE	3	0	0	3	3	40	60	100	PE
21EE014	DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES	3	0	0	3	3	40	60	100	PE
21EE015	ELECTRIC VEHICLE DESIGN, MECHANICS AND CONTROL	3	0	0	3	3	40	60	100	PE
21EE016	DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM	3	0	0	3	3	40	60	100	PE
21EE017	GRID INTEGRATION OF ELECTRIC VEHICLES	3	0	0	3	3	40	60	100	PE
21EE018	INTELLIGENT CONTROL OF ELECTRIC VEHICLES	3	0	0	3	3	40	60	100	PE
<b>VERTICAL IV - GREEN ENERGY TECHNOLOGY</b>										
21EE019	SOLAR ENERGY CONVERSION SYSTEMS	3	0	0	3	3	40	60	100	PE
21EE020	WIND POWER TECHNOLOGY	3	0	0	3	3	40	60	100	PE
21EE021	FUEL CELL SYSTEMS	3	0	0	3	3	40	60	100	PE
21EE022	RENEWABLE ENERGY SYSTEMS INSTALLATIONS AND	3	0	0	3	3	40	60	100	PE

21EE023	ENERGY STORAGE SYSTEMS	3	0	0	3	3	40	60	100	PE
21EE024	GRID INTEGRATION OF RENEWABLE SOURCES	3	0	0	3	3	40	60	100	PE
<b>VERTICAL V - EMBEDDED SYSTEM DESIGN</b>										
21EE025	ADVANCED PROCESSOR ARCHITECTURES	3	0	0	3	3	40	60	100	PE
21EE026	COMMUNICATION PROTOCOLS AND STANDARDS	3	0	0	3	3	40	60	100	PE
21EE027	EMBEDDED C PROGRAMMING	3	0	0	3	3	40	60	100	PE
21EE028	REAL TIME OPERATING	3	0	0	3	3	40	60	100	PE
21EE029	EMBEDDED LINUX	3	0	0	3	3	40	60	100	PE
21EE030	VIRTUAL INSTRUMENTATION IN EMBEDDED SYSTEMS	3	0	0	3	3	40	60	100	PE
<b>VERTICAL VI - ELECTRICAL TECHNOLOGY</b>										
21EE031	UTILIZATION OF ELECTRICAL ENERGY	3	0	0	3	3	40	60	100	PE
21EE032	INDUSTRIAL ELECTRONICS	3	0	0	3	3	40	60	100	PE
21EE033	ILLUMINATION ENGINEERING	3	0	0	3	3	40	60	100	PE
21EE034	ELECTRICAL SAFETY	3	0	0	3	3	40	60	100	PE
21EE035	ENERGY AUDITING AND MANAGEMENT	3	0	0	3	3	40	60	100	PE
21EE036	PLC AND SCADA	3	0	0	3	3	40	60	100	PE
21EE037	ARTIFICIAL INTELLIGENCE IN ELECTRICAL ENGINEERING	3	0	0	3	3	40	60	100	PE
21EE038	BIG DATA ANALYTICS FOR SMART GRID	3	0	0	3	3	40	60	100	PE
21EE039	INDUSTRY 4.0	3	0	0	3	3	40	60	100	PE

<b>HONOURS DEGREE (With Specialization )</b>										
<b>VERTICAL I - POWER SYSTEMS</b>										
21EEH01	POWER SYSTEM OPERATION AND CONTROL	3	0	0	3	3	40	60	100	PE
21EEH02	POWER QUALITY	3	0	0	3	3	40	60	100	PE
21EEH03	HIGH VOLTAGE TRANSMISSION	3	0	0	3	3	40	60	100	PE
21EEH04	DEMAND SIDE MANAGEMENT	3	0	0	3	3	40	60	100	PE
21EEH05	SMART GRID TECHNOLOGIES	3	0	0	3	3	40	60	100	PE
21EEH06	POWER SYSTEM DEREGULATION	3	0	0	3	3	40	60	100	PE

<b>MINOR DEGREE (Other than EEE Students )</b>										
<b>VERTICAL I - POWER SYSTEMS</b>										
21EEM01	POWER SYSTEM OPERATION AND CONTROL	3	0	0	3	3	40	60	100	PE
21EEM02	POWER QUALITY	3	0	0	3	3	40	60	100	PE
21EEM03	HIGH VOLTAGE TRANSMISSION	3	0	0	3	3	40	60	100	PE
21EEM04	DEMAND SIDE MANAGEMENT	3	0	0	3	3	40	60	100	PE
21EEM05	SMART GRID TECHNOLOGIES	3	0	0	3	3	40	60	100	PE
21EEM06	POWER SYSTEM DEREGULATION	3	0	0	3	3	40	60	100	PE

**SUMMARY OF CREDIT DISTRIBUTION**

S.No	CATEGORY	CREDITS PER SEMESTER								TOTAL CREDIT	CREDITS in %	Range of Total Credits	
		I	II	III	IV	V	VI	VII	VIII			Min	Max
1	BS	10	10	4	4					28	17	15%	20%
2	ES	5	10	8	3					26	16	15%	20%
3	HSS	2	2					2		6	4	5%	10%
4	PC			12	16	18	13	4		63	39	30%	40%
5	PE					6	9	12		27	17	10%	15%
6	EEC							3	9	12	7	10%	15%
Total		17	22	24	23	24	22	21	9	162	100	-	-

- BS - Basic Sciences  
 ES - Engineering Sciences  
 HSS - Humanities and Social Sciences  
 PC - Professional Core  
 PE - Professional Elective  
 EEC - Employability Enhancement Course  
 CA - Continuous Assessment  
 ES - End Semester Examination

**18EE101 ENGINEERING MATHEMATICS I****3 1 0 4****Course Objectives**

- Understand the concepts of vectors and Eigen vectors for different matrices to describe the stability of the linear systems in engineering fields.
- Exemplify the concepts of differentiation and integration to identify the area of 2D and 3D surfaces in engineering problems
- Explain the concepts of analytic functions in complex domain to predict the nature of different engineering systems.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

**Course Outcomes (COs)**

- Apply the principles of coordinate systems in the complex plane and characteristics of linear systems by Eigen values and Eigen vectors.
- Analyse various types of functions and their differentiation techniques involved in engineering fields.
- Apply different methods of integration to solve the engineering problems.
- Execute the suitable integration technique to calculate the area and volume of different surfaces.
- Apply the concept of analytic function to estimate the integral in complex plane.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	-	-	-	-	-	-	-	-	-	2	-
2	2	2	-	-	-	-	-	-	-	-	-	-	3	-
3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
4	1	2	-	-	-	-	-	-	-	-	-	-	2	-
5	2	2	-	-	-	-	-	-	-	-	-	-	3	-

**UNIT I****9 Hours****COMPLEX NUMBERS, VECTORS AND MATRICES**

Complex plane, polar coordinates and polar form of complex numbers, powers and roots, fundamental theorem of algebra. Vector algebra in 2-D and 3-D space, dot product and cross product. Matrices : Eigen values and Eigen vectors, Properties of eigen values and eigen vectors.

**UNIT II****9 Hours****CALCULUS**

Limits and Continuity of Functions: Limits of functions, types of limits, evaluation of limits, continuity of functions, properties of continuous functions. Derivatives: Derivatives, differentiability, rules and properties, differentiation of transcendental functions, higher order derivatives, implicit differentiation, and differentiation of hyperbolic functions. Integration: Anti-derivatives, Riemann Sum, indefinite and definite integration, Mean Value Theorem for definite integral, Fundamental Theorem of Calculus.

**UNIT III****9 Hours****INTEGRATION METHODS**

Basic integration formulae for algebraic and transcendental functions. Integration by special devices: integration by parts, rationalizing substitution or trigonometric substitution, partial fractions, reduction formulas, improper integrals, convergence tests.

**UNIT IV**

**9 Hours**

**APPLICATIONS OF DERIVATIVES AND INTEGRATIONS**

Extreme values, points of inflection and curve sketching, Rolles Theorem, Mean Value Theorem, optimization, indeterminate forms, L Hopital s Rule. Area between curves, volume of a general solid by slicing and cylindrical shell methods, volume of a solid of revolution, length of plane curves, area of a surface of revolution.

**UNIT V**

**9 Hours**

**COMPLEX ANALYSIS**

Analytic Functions- Properties of Analytic function - Determination of Analytic Function using Milne Thompson method. Cauchy s Integral Formula - Classification of Singularities - Cauchy s Residue Theorem.

**FOR FURTHER READING**

Quadratic forms - Application of conic sections, quadratic surfaces - discrete dynamical systems - Triple integral in polar coordinates-Formation of Bus Admittance Matrices. Applications of mass spring system in ordinary differential equations of higher order.

**Total: 60 Hours**

**Reference(s)**

1. Finney RL, Weir MD and Giordano FR, Thomas Calculus, 10th edition, Addison-Wesley, 2001
2. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi, 2016.
3. Anton H, Calculus with Analytic Geometry, 5th edition, John Wiley & Sons, 1995
4. Ayres F Jr and Mendelson E, Schaum s Outline of Theory and Problems of Calculus, 4th edition, McGraw Hill, 1999.
5. Smith RT and Minton RB, Calculus, 2nd Edition, McGraw Hill, 2002.

**18EE102 ENGINEERING PHYSICS I****2023****Course Objectives**

- Illustrate the Newtons laws of motion and wave motion with applications
- Understand the basic properties of electricity, magnetism and optics
- Differentiate the special theory of relativity and quantum physics from classical physics

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

**Course Outcomes (COs)**

- Apply the Newton's three laws of motion to solve the real world problems involving elevator, at wood machine and acceleration of objects.
- Differentiate the physical characteristics of simple harmonic motion, wave motion and find the solutions for wave equations.
- Analyse the electric and magnetic elements using the fundamental laws and properties of electricity and magnetism.
- Justify the characteristics of mirrors, lenses, microscopes and diffraction gratings using the concepts of physical and geometrical optics
- Conclude the wave and particle nature of matter with special theory of relativity and quantum physics.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	-	-	-	-	-	2	2	-	-	1	-
2	2	1	-	-	-	-	-	-	2	2	-	-	2	-
3	2	2	-	-	-	-	-	-	2	2	-	-	1	-
4	2	2	-	-	-	-	-	-	2	2	-	-	2	-
5	2	1	-	-	-	-	-	-	2	2	-	-	1	-

**UNIT I****6 Hours****MECHANICS**

Newtons laws of motion: Concept of force and its nature - Newtons first law and inertial frames - definition of mass - Newtons second law-gravitational force and weight - Newtons third law. Applications of Newtons laws: particle in equilibrium, particle under net force - weighing a mass in an elevator, the atwood machine and acceleration of two objects connected by a cord

**UNIT II****6 Hours****OSCILLATIONS AND WAVES**

Fundamentals of simple harmonic motion - energy of simple harmonic oscillator - spring mass system - time period of simple pendulum, compound pendulum and torsional pendulum - Damped oscillations. Travelling wave motion - sinusoidal waves on strings - speed of a wave - reflection and transmission - rate of energy transfer in wave motion

<b>UNIT III</b>	<b>6 Hours</b>
<b>ELECTRICITY AND MAGNETISM</b>	
Point charges - electric fields - Gauss law and its applications - electric potential - capacitance - energy stored in a capacitor. Concept and source of magnetic fields - Amperes theorem - determination of magnetic field due to different current distributions - Faradays law - self-induction and mutual induction - energy stored in an inductor	
<b>UNIT IV</b>	<b>6 Hours</b>
<b>LIGHT AND OPTICS</b>	
Nature of light - laws of reflection and refraction - refractive index and Snells law - dispersion of light - total internal reflection - image formation: concave mirrors - convex mirrors - thin lenses - compound microscope - human eye. Conditions of interference - Youngs double slit experiment - intensity distribution of interference - phase change due to reflection - diffraction-narrow slit diffraction - single slit and two slit - intensity distribution - diffraction grating – applications.	
<b>UNIT V</b>	<b>6 Hours</b>
<b>MODERN PHYSICS</b>	
Special theory of relativity - simultaneity and time dilation - twin paradox - length contraction - relativistic mass variation - space time graph. Black body radiation and Planck hypothesis - allowed energy levels - thermal radiation from different objects - photoelectric and Compton effect. Matter waves - de-Broglie hypothesis - wave nature of particles - Davission-Germer experiment	
<b>1</b>	<b>5 Hours</b>
<b>EXPERIMENT 1</b>	
Determination of resultant of system of concurrent coplanar forces-Parallelogram law of forces	
<b>2</b>	<b>5 Hours</b>
<b>EXPERIMENT 2</b>	
Determination of moment of inertia-Torsional pendulum	
<b>3</b>	<b>5 Hours</b>
<b>EXPERIMENT 3</b>	
Determination of wavelength of mercury spectral lines-spectrometer	
<b>4</b>	<b>4 Hours</b>
<b>EXPERIMENT 4</b>	
Determination of refractive index of solid and liquid-travelling microscope	
<b>5</b>	<b>3 Hours</b>
<b>EXPERIMENT 5</b>	
Determination of wavelength of laser-diffraction grating	
<b>6</b>	<b>4 Hours</b>
<b>EXPERIMENT 6</b>	
Determination of frequency of a tuning fork-Meldes apparatus	
<b>7</b>	<b>4 Hours</b>
<b>EXPERIMENT 7</b>	
Thickness of a thin wire using interference of light-Air wedge method	

**Total: 60 Hours**

**Reference(s)**

1. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2011
2. Halliday and Resnick, Fundamentals of Physics, John Wiley and Sons, Inc, 2011
3. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers & Distributors, New Delhi, 2017
4. H D Young and R A Freedman, Sears and Zemanskys University Physics with Modern Physics, Pearson education, 2016
5. R K Gaur and S L Gupta, Engineering Physics, Dhanpat Rai Publications, 2012.

**18EE103 ENGINEERING CHEMISTRY I****2023****Course Objectives**

- Recall the terminologies of electrochemistry and explain the function of electrode with its electrochemical reactions.
- Infer the construction, cell reactions and working in batteries.
- Classify the conducting property of the material based on resistivity and predict their applications.
- Outline the fundamentals of corrosion, its types and protection methods.
- Outline the purpose of alloying, properties and its application.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
  - 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.
  - Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
  - Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Apply the electrochemical concepts to determine the electrode potential of the given metal.
- Analyze the cell reactions taking place during charging and discharging of primary and secondary batteries with its applications and disposal methods.
- Assess the significance of high-resistivity materials in industrial and electronic applications.
- Analyze the two mechanisms of corrosion to identify effective corrosion protection methods on metallic objects.
- Analyze the properties of ferrous and non-ferrous alloys in electronics industries.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	-	-	-	-	-	-	-	2	2	-	-	-	2
2	2	1	-	-	-	-	-	-	2	2	-	-	-	-
3	1	2	-	-	-	-	-	-	2	2	-	-	2	-
4	1	1	-	-	-	-	-	-	2	2	-	-	1	-
5	2	2	-	-	-	-	-	-	2	2	-	-	2	-

**UNIT I****7 Hours****BASICS OF ELECTROCHEMISTRY**

Electrodes - types of electrodes. Cells - types - applications - redox reactions and its determination.

**UNIT II****6 Hours****BATTERIES**

Batteries - construction - types - primary and secondary - modern batteries - cell reactions and applications - disposal of batteries.

<b>UNIT III</b>	<b>6 Hours</b>
<b>ELECTRICAL CONDUCTING MATERIALS</b>	
Electrical conducting materials - classification based on resistivity - significance of low resistivity metals (Cu, Al and Fe) - thermal conductivity of metals - high resistivity materials and their applications (manganin, constantin, nichrome, mercury, and tungsten).	
<b>UNIT IV</b>	<b>6 Hours</b>
<b>CORROSION CONTROL AND PROTECTIVE COATING</b>	
Corrosion - types - galvanic series and its applications. Corrosion control methods: Sacrificial anode and impressed current cathodic method- protective coating - electroplating - electroless plating - application in Printed Circuit Board (PCB).	
<b>UNIT V</b>	<b>5 Hours</b>
<b>ALLOYS</b>	
Purpose of alloying - properties and classification of alloys - manufacturing of alloys for electrical machineries.	
<b>FURTHER READING</b>	
Fuel cells: Principle, construction and applications of hydrogen-oxygen fuel cell, solid oxide fuel cell (SOFC) and proton exchange membrane fuel cell.	
<b>1</b>	<b>4 Hours</b>
<b>EXPERIMENT 1</b>	
Determination of standard electrode potential of electrical conducting metal using calomel as reference electrode.	
<b>2</b>	<b>4 Hours</b>
<b>EXPERIMENT 2</b>	
Construct a cell (using scrap metal/ other sources) exhibiting valid output and compare it with the existing commercial batteries based on output.	
<b>3</b>	<b>4 Hours</b>
<b>EXPERIMENT 3</b>	
Evaluation of chemical earthing materials by the given data analyzed by AAS spectroscopy and their output.	
<b>4</b>	<b>5 Hours</b>
<b>EXPERIMENT 4</b>	
Electroplating of copper on a given target object and estimate the amount of copper at anode.	
<b>5</b>	<b>9 Hours</b>
<b>EXPERIMENT 5</b>	
(a) Determination of corrosion percentage of electrical materials by weight loss method. (b) Correlation between conductivity and corrosion rates in Fe- Carbon- Steels- Cu under different environments (5)	
<b>6</b>	<b>4 Hours</b>
<b>EXPERIMENT 6</b>	
Estimation of Cu content in brass by EDTA method.	

**Total: 60 Hours**

**Reference(s)**

1. Jain and Jain, Engineering Chemistry, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2013.
2. P.H. Rieger, Electrochemistry, Second Edition (Reprint), Springer, Netherland, 2012.
3. E.McCafferty, Introduction to Corrosion Science, Springer; 2010 Edition, January 2010.
4. S. Vairam, Engineering Chemistry, John Wiley & sons, 2014.
5. O.P Khanna, Materials Science and Metallurgy, Dhanpat Rai Publishing Company, New Delhi, 2013.
6. Electrical and Electronic Engineering Materials, SK Bhattacharya, Khanna Publishers, New Delhi.

**Course Objectives**

- Understand the basics of C primitives, operators and expressions.
- Gain knowledge about the different primitive and user defined data types.
- Impart knowledge about the structural programming concepts.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching
- 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, substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 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.
- 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.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

**Course Outcomes (COs)**

1. Implement C programs using operators, type conversion and input-output functions.
2. Apply decision making and looping statements in writing C programs.
3. Develop C programs using the concepts of Arrays and strings.
4. Apply the concepts of functions and pointers in writing C programs.
5. Design applications using structures, unions and files in C.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	1	-	3	-	-	-	-	2	-	1	3	-
2	2	1	-	2	3	-	-	-	-	2	-	1	3	-
3	1	3	2	-	3	-	-	-	-	2	-	2	3	-
4	1	3	-	2	3	-	-	-	2	2	1	2	3	-
5	1	3	2	-	3	-	-	1	2	2	2	2	3	-

**UNIT I**

**6 Hours**

**INTRODUCTORY CONCEPTS**

C Primitives: Introduction to C- Planning and writing a C program- Character Set - Keywords and Identifiers - Data Types - Variables and Constants - Compiling and executing the C program Operators and Expressions: Arithmetic - Relational - Logical - Increment and decrement - Conditional - Bitwise - Comma - Sizeof() - Assignment - Shift operator - Precedence and order of evaluation - Type Conversion

**UNIT II**

**6 Hours**

**CONTROL STATEMENTS**

Decision Making and Branching: simple if statement - if else statement - nesting of if else Statement - Switch Statement.  
Decision Making and Looping: while statement - do while statement - for statement  
Jump Statements: goto - break - continue - return statement

**UNIT III**

**6 Hours**

**ARRAYS AND STRINGS**

Arrays: Introduction, one dimensional array, two-dimensional arrays and multi dimensional arrays.  
Strings: Declaring and initializing string variables- Reading and writing strings - String handling functions.

**UNIT IV**

**6 Hours**

**FUNCTIONS AND POINTERS**

User Defined Functions: Elements of user defined functions - Definition of functions - return values and their types - function calls - categories of function - call by value and call by reference - recursion  
Pointers: Understanding Pointers - accessing the address of the variable - declaring pointer variables - Initialization of pointer variables - Accessing a variable through its pointer

**UNIT V**

**6 Hours**

**STRUCTURES AND FILES**

Storage Class Specifiers: Auto - registers - static - extern - typedef Structures and Unions: Introduction - defining a structure - declaring structure variables - accessing structure members - structure initialization -Unions File Management in C: Defining and opening a file - closing a file - Input/output operations on files.

**FOR FURTHER READING**

Problem solving - Logical thinking - logic - symbolic logic - truth tables - Math puzzles – magic triangles - magic squares - alphabetic puzzles - Cross number puzzles. Creating and manipulating document using word - Mail merge - Creating spread sheet with charts and formula using excel - developing power point presentation with Animations.

**1**

**3 Hours**

**EXPERIMENT 1**

Write a C program to perform arithmetic operations on integers and floating point numbers.

**2**

**3 Hours**

**EXPERIMENT 2**

Write a C program to implement ternary operator and relational operators.

**3**

**3 Hours**

**EXPERIMENT 3**

Write a C program to read the values of A,B,C through the keyboard. Add them and after addition check if it is in the range of 100 to 200 or not. Print separate message for each.

**4** **3 Hours**

**EXPERIMENT 4**

Write a C program to display the roots of a quadratic equation with their types using switch case.

**5** **3 Hours**

**EXPERIMENT 5**

Write a C program to generate the following triangle.

```
1
1 2 3
1 2 3 4 5
1 2 3 4 5 6 7
```

**6** **3 Hours**

**EXPERIMENT 6**

Write a C program to get a matrix of order 3x3 and display a matrix of order of 4x4, with the fourth row and column as the sum of rows and columns respectively.

**7** **3 Hours**

**EXPERIMENT 7**

Write a C program to remove the occurrence of "the" word from entered string.

**8** **3 Hours**

**EXPERIMENT 8**

Write a C program to find the factorial of given number.

**9** **3 Hours**

**EXPERIMENT 9**

Design a structure to hold the following details of a student. Read the details of a student and display them in the following format Student

details: rollno, name, branch, year, section, cgpa.

\*\*\*\*\*

```
NAME:
ROLL NO:
BRANCH:
YEAR:
SECTION:
CGPA:
```

**10** **3 Hours**

**EXPERIMENT 10**

Create two files test1.txt and test2.txt and write a C program to read the file text1.txt character by character on the screen and paste it at the end of test2.txt.

**Total: 60 Hours**

**Reference(s)**

1. Herbert Schildt, C -The complete Reference, Tata McGraw-Hill, 2013
2. Byron Gottfried , Programming with C, Schaum's Outlines, Tata Mcgraw-Hill, 2013
3. E.Balagurusamy, Programming in ANSIC, Tata McGraw-Hill, 2012
4. Kernighan B W and Ritchie O M, The C programming Language. Prentice-Hall of India, 2009
5. Kelley A and I. Pohl, A Book on C : Programming in C, Pearson Education, 1998
6. Ashok.N.Kamthane,Programming in C,Pearson education,2013.

**18HS101 COMMUNICATIVE ENGLISH I****1 0 2 2****Course Objectives**

- Read and understand the main points on familiar matters regularly encountered in work, school, or leisure
- Listen and respond in most common situations where English is spoken
- Write simple connected texts on topics which are familiar or of personal interest
- Describe experiences and events, hopes and ambitions and briefly give reasons and explanations for opinions and plans

**Programme Outcomes (POs)**

- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

**Course Outcomes (COs)**

1. Apply appropriate grammar and vocabulary that aligns with the expectations of the Competitive exam level.
2. Analyze the general meaning of non-routine letters within your work area, and find key details in short reports of a predictable nature.
3. Construct straightforward, routine letters of a factual nature, and select relevant information to make notes on routine matters, such as taking or placing orders.
4. Use simple presentations or demonstrations and demonstrate understanding by summarizing key points
5. Resolve predictable requests from a visitor, outline routine requirements, and offer advice within your job area on simple matters.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	3	3	-	-	1	-
2	-	-	-	-	-	-	-	-	3	3	-	-	1	-
3	-	-	-	-	-	-	-	-	3	3	-	-	1	-
4	-	-	-	-	-	-	-	-	3	3	-	-	1	-
5	-	-	-	-	-	-	-	-	3	3	-	-	1	-

**UNIT I****9 Hours****GRAMMAR**

Tenses Future continuous, Past continuous, Past perfect, Past simple, Past tense responses, Present perfect continuous, Present perfect/past simple Reported speech Adverbs intensifiers Comparatives and superlatives Conditionals 2nd and 3rd Connecting words expressing cause and effect, contrast Phrasal verbs Prepositions of place Simple passive - Wh-questions in the past Question tags Will and going to, for prediction.

**UNIT II**

**9 Hours**

**READING**

Understanding short real-world notices, messages Detailed comprehension of factual material; skimming and scanning skills - Interpreting visual information Reading for detailed factual information Reading for gist and specific information - Grammatical accuracy and understanding of text structure - Reading and information transfer.

**UNIT III**

**9 Hours**

**WRITING**

Internal communication including note, message, memo or email - arranging / rearranging appointments, asking for permission, giving instructions - Business correspondence including letter, fax, email apologising and offering compensation, making or altering reservations, dealing with requests, giving information about a product.

**UNIT IV**

**9 Hours**

**LISTENING**

Listening for specific information Listening for numbers and letters Note completion Listening for gist listening to monologues (presentations, lectures, announcements and briefings) listening to interacting speakers (telephone conversations, face-to-face conversations, interviews and discussions).

**UNIT V**

**9 Hours**

**SPEAKING**

Exchanging personal and factual information expressing and finding out about attitudes and opinions organise a larger unit of discourse Turn-taking, negotiating, collaborating, exchanging information, expressing and justifying opinions, agreeing and/or disagreeing, suggesting, speculating, comparing and contrasting, and decision-making.

1. Goodbye party for Miss Pushpa T S - Nissim Ezekiel
2. Our Casuarina Tree - Toru Dutt
3. Palanquin Bearers - Sarojini Naidu
4. The Tyger - William Blake
5. Ode on a Grecian Urn - John Keats

**Total: 45 Hours**

**Reference(s)**

1. Alexander Garrett, Cambridge BEC Preliminary Students Book with Answers, Cambridge University Press, 2016.
2. Lan Wood, Anne Williams and Anna Cowper. Pass Cambridge BEC Preliminary, Second Edition, New Delhi, 2014.
3. Norman Whitby. Cambridge Business Benchmark. Pre-Intermediate to Intermediate, Students Book. South Asian Edition, 2018.

**18EE106 ENGINEERING PRACTICES LABORATORY****0 0 4 2****Course Objectives**

- To provide hands on training for dismantling and assembling of starters and transformers.
- To develop the skills for making simple electrical wiring connections using suitable tools.
- To develop the skill for trouble shooting and maintenance of home appliances.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- 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.
- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 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.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Construct electrical circuits to demonstrate the current and voltage division rule and measure electrical parameters using multimeters.
- Demonstrate soldering techniques by assembling and troubleshooting simple Printed Circuit Boards.
- Apply knowledge of logic gates to demonstrate their truth tables in digital circuits.
- Construct electrical wiring systems and demonstrate the measurement of earth resistance.
- Demonstrate the working of repaired home appliances using suitable troubleshooting methods.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	-	-	-	2	-	-	2	2	-	2	3	-
2	2	-	-	-	-	2	-	-	2	2	-	2	-	3
3	2	-	-	-	-	2	-	-	2	2	-	2	2	-
4	2	-	-	-	-	2	2	-	2	2	-	2	2	2
5	2	-	-	-	-	2	2	-	2	2	-	2	-	2

<b>1</b>		<b>6 Hours</b>
<b>EXPERIMENT 1</b>		
Measurement of electrical parameters using multimeters.		
<b>2</b>		<b>6 Hours</b>
<b>EXPERIMENT 2</b>		
Verification of current division for parallel circuit.		
<b>3</b>		<b>6 Hours</b>
<b>EXPERIMENT 3</b>		
Verification of voltage division for series circuit.		
<b>4</b>		<b>6 Hours</b>
<b>EXPERIMENT 4</b>		
Soldering Practice for simple Printed Circuit Board (PCB).		
<b>5</b>		<b>6 Hours</b>
<b>EXPERIMENT 5</b>		
Verification of Logic gates truth table.		
<b>6</b>		<b>6 Hours</b>
<b>EXPERIMENT 6</b>		
Construct electrical wire connections for staircase wiring and godown wiring with MCB.		
<b>7</b>		<b>6 Hours</b>
<b>EXPERIMENT 7</b>		
Trouble shooting and Maintenance of Table Fan/Ceiling Fan.		
<b>8</b>		<b>6 Hours</b>
<b>EXPERIMENT 8</b>		
Trouble shooting and Maintenance of grinder/ mixer grinder.		
<b>9</b>		<b>6 Hours</b>
<b>EXPERIMENT 9</b>		
Trouble shooting and Maintenance of Fluorescent Lamp circuit.		
<b>10</b>		<b>6 Hours</b>
<b>EXPERIMENT 10</b>		
Measurement of earth resistance.		
		<b>Total: 60 Hours</b>

**18EE201 ENGINEERING MATHEMATICS II****3 1 0 4****Course Objectives**

- Understand the concepts of partial derivatives and multiple integrals to define the area, volume and extreme values of various surfaces in engineering fields.
- Classify the sequences and series in linear systems is convergent or divergent.
- Formulate the real time engineering problem into mathematical model using ordinary differential equation and solve it by appropriate method.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

**Course Outcomes (COs)**

1. Apply the concepts of partial differentiation to evaluate various parameters in signals and systems and characterize maxima and minima of functions for optimization problems.
2. Apply multiple integral concepts to calculate the area and volume by appropriate vector integral theorems.
3. Analyse the convergence and divergence of sequences and series by various tests.
4. Apply mathematical concepts to construct first-order differential equations derived from real-time phenomena and solve them using appropriate analytical methods.
5. Execute the appropriate method to solve the second order differential equations.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	-	-	-	-	-	-	-	-	-	1	-
2	2	2	-	-	-	-	-	-	-	-	-	-	2	-
3	2	1	-	-	-	-	-	-	-	-	-	-	2	-
4	2	1	-	-	-	-	-	-	-	-	-	-	1	-
5	2	1	-	-	-	-	-	-	-	-	-	-	1	-

**UNIT I****9 Hours****PARTIAL DIFFERENTIATION**

Functions of several variables, plotting of 2-variable functions, introduction to cylindrical and spherical coordinates, chain rule, total differential, gradient, directional derivatives, normal lines and tangent planes, extreme of functions of two variables, applications.

**UNIT II****9 Hours****MULTIPLE INTEGRALS**

Double integrals, regions of integrations, triple integrals, applications (Cartesian coordinates only- Greens theorem and Gauss Divergence theorem).

**UNIT III****9 Hours****SEQUENCES AND SERIES**

Sequences and series, convergence and divergence of series, absolute convergence, conditional convergence, test for convergence and divergence. Power series for functions, interval of convergence, Taylor and Maclaurin series, Taylors Theorem with remainder.

**UNIT IV**

**9 Hours**

**FIRST ORDER DIFFERENTIAL EQUATIONS**

Separable differential equations, homogeneous differential equations, exact differential equations, integrating factor, Bernoullis equation, applications.

**UNIT V**

**9 Hours**

**SECOND ORDER DIFFERENTIAL EQUATIONS**

Second order homogeneous and non-homogeneous equations with constant coefficients, variation of parameters, method of undetermined coefficients, series solutions of differential equations, applications.

**FOR FURTHER READING**

Applications to Electrostatic and Fluid Flow.

**Total: 60 Hours**

**Reference(s)**

1. Finney RL, Weir MD and Giordano FR, Thomas Calculus, 10th edition, Addison-Wesley, 2001
2. Erwin Kreyszig , Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi 2016.
3. Smith RT and Minton RB, Calculus, 2nd Edition, McGraw Hill, 2002.
4. Ray Wylie and C Louis Barrett, Advanced Engineering Mathematics, Sixth Edition, Tata McGraw-Hill Publishing Company Ltd, 2003.
5. Peter V. O Neil , Advanced Engineering Mathematics, Seventh Edition , Cengage Learning India Private Limited, 2012.
6. Glyn James, Advanced Engineering Mathematics, Third Edition, Wiley India, 2014.

**18EE202 ENGINEERING PHYSICS II****2023****Course Objectives**

- Understand the fundamentals of crystal, transport properties of semiconductors and magnetic materials
- Differentiate passive and active components
- Compare different display devices and their functions

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
  - 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.
  - Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

**Course Outcomes (COs)**

- Compute the seven types of crystal systems, crystal planes and illustrate unit cell characteristics of SC, BCC, FCC and HCP crystal structures.
- Conclude the characteristics of semiconducting materials in terms of crystal lattice, charge carriers and energy band diagrams.
- Differentiate the active and passive components in an electronic circuit and outline the working mechanisms of diodes.
- Analyse the properties of magnetic materials, domain theory of ferromagnetism and the applications of recording and readout process.
- Outline the interaction of electromagnetic radiation with matter and working principle of LED, LCD and OLED display devices

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	-	-	-	-	-	2	2	-	-	2	-
2	2	1	-	-	-	-	-	-	2	2	-	-	2	-
3	2	1	-	-	-	-	-	-	2	2	-	-	2	-
4	2	1	-	-	-	-	-	-	2	2	-	-	2	-
5	2	1	-	-	-	-	-	-	2	2	-	-	1	-

**UNIT I****6 Hours****CRYSTAL PHYSICS**

Classification of solids - crystal structure - lattice points and space lattice - unit cell and lattice parameters - crystal systems and Bravais lattices - crystallographic planes - Miller indices - interplanar space of lattice planes - anisotropic properties of crystal - unit cell characteristics of SC, BCC, FCC and HCP structures

<b>UNIT II</b>	<b>7 Hours</b>
<b>SEMICONDUCTING MATERIALS</b>	
Band theory of solids - classification of solids - electrical and thermal conductivity - Semiconductors: elemental and compound semiconductor - intrinsic and extrinsic semiconductors - energy band diagram and electrical conduction - variation of Fermi level with temperature and impurity concentration - temperature dependence of carrier concentration in extrinsic semiconductor - Hall effect - determination of Hall coefficient - solar cells.	
<b>UNIT III</b>	<b>5 Hours</b>
<b>PASSIVE AND ACTIVE COMPONENTS</b>	
Fundamental definitions - types of resistors, capacitors, inductors and transformers - characteristics of PN junction. Diodes: laser diode - PIN diode - Schottky diode - step recovery diode - tunnel diode - varactor diode - Zener diode	
<b>UNIT IV</b>	<b>6 Hours</b>
<b>MAGNETIC MATERIALS</b>	
Basic definitions - origin of magnetic moment - classification of magnetic materials - influence of temperature on magnetic behaviour - domain theory of ferromagnetism - hysteresis of ferromagnetic materials - soft and hard magnetic materials - applications: magnetic recording - giant magneto resistance (GMR) effect	
<b>UNIT V</b>	<b>6 Hours</b>
<b>DISPLAY DEVICES</b>	
Electromagnetic radiation - interaction of radiation with solids - classification of optical materials - luminescence - types of luminescence - LED and OLED: principle, construction, working, advantages and disadvantages. LCD: characteristics of liquid crystals - types - phases - twisted nematic display: construction, working, merits and demerits. Comparison of LED, OLED and LCD	
<b>1</b>	<b>5 Hours</b>
<b>EXPERIMENT 1</b>	
Measurement of resistivity of a given material by four probe method	
<b>2</b>	<b>5 Hours</b>
<b>EXPERIMENT 2</b>	
Find the Hall coefficient and carrier concentration of semiconducting material using Hall effect apparatus	
<b>3</b>	<b>5 Hours</b>
<b>EXPERIMENT 3</b>	
Determine the V-I characteristics of a solar cell	
<b>4</b>	<b>5 Hours</b>
<b>EXPERIMENT 4</b>	
Find the band gap value of the given semiconductor diode. Based on the band gap value, identify the given semiconductor	
<b>5</b>	<b>5 Hours</b>
<b>EXPERIMENT 5</b>	
Determine the V-I characteristics of P-N diode and Zener diode	
<b>6</b>	<b>5 Hours</b>
<b>EXPERIMENT 6</b>	
Determine the thermal conductivity of a bad conductor by using Lee's disc method	
<b>Total: 60 Hours</b>	

**Reference(s)**

1. Balasubramaniam, R. "Callister's Materials Science and Engineering". Wiley India Pvt.Ltd., 2014.
2. Kasap, S.O. "Principles of Electronic Materials and Devices". McGraw-Hill Education,2017
3. William D. Callister, Jr. & David G. Rethwisch "Fundamentals of Materials Science and Engineering".John Wiley and Sons Incl.,2008.
4. Wahab, M.A. "Solid State Physics: Structure and Properties of Materials". Alpha Science International Ltd., 2017
5. Donald A. Neamen. "Semiconductor Physics and Devices", Mc Graw-Hill, 2011
6. Palanisamy P. K."Physics for electronics and information science". Dipti Press Pvt. Ltd., 2018.
7. Papadopoulos, Christo, Solid-State Electronic Devices An Introduction, Springer, NewYork, 2014.
8. Raghavan, V. "Materials Science and Engineering: A First course". PHI Learning, 2015.
9. B.L.Theraja, Basic Electronics Solid State, S.Chand& Company Ltd, New Delhi, 2000.

**18EE203 ENGINEERING CHEMISTRY II****2023****Course Objectives**

- Summarize the unique properties of group IV elements and their applications in electronics
- Apply the basic knowledge of conducting polymers for electrical applications
- Infer the materials used in insulation of electrical signals
- Outline the chemistry of materials used in ceramic insulators and resistors
- Illustrate the novel nanofabrication techniques for nano electronic applications

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Apply the knowledge of the structural and chemical properties of Group IV elements and their oxides to evaluate their suitability for fabricate integrated circuits.
- Analyze the suitability of conducting polymer for optical and storage applications.
- Compare the advantages of nano-material over conventional material for the fabrication of nano electronic components.
- Assess the properties of ceramic insulators to determine their suitability for electronic applications.
- Analyze the morphology of materials using AFM, SEM, TEM techniques

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	-	-	2	-	2	2	2	-	-	1	-
2	2	1	-	-	-	-	-	2	2	-	-	-	2	-
3	2	2	-	-	-	-	1	2	2	-	-	-	3	-
4	2	2	-	-	-	2	-	2	2	-	-	-	-	2
5	2	1	-	-	-	-	1	2	2	2	-	-	1	-

<b>UNIT I</b>	<b>6 Hours</b>
<b>CHEMISTRY OF SEMICONDUCTORS</b>	
Group IV elements - structure and properties - oxides of silicon and germanium - applications in electronics- IC device and VLSI design fabrication.	
<b>UNIT II</b>	<b>6 Hours</b>
<b>POLYMERS AND CONDUCTING POLYMERS</b>	
Polymers - conducting polymers - commercial polymers: Synthesis and applications - optical fibres - functions and applications.	
<b>UNIT III</b>	<b>5 Hours</b>
<b>INSULATING MATERIALS</b>	
Dielectrics - characteristics and types - insulating materials - resins - thermal insulators.	
<b>UNIT IV</b>	<b>7 Hours</b>
<b>ELECTRONIC CERAMICS</b>	
Properties of ceramic insulators - ceramic capacitor materials - ferrite (magnetic) ceramics - ceramic sensors. Application and characterization of ZnO varistors. Resistor materials: Carbon based materials - metal-based materials.	
<b>UNIT V</b>	<b>6 Hours</b>
<b>NANOELECTRONICS</b>	
Nanoelectronics - introduction - nanoelectronic architectures: Nanofabrication - nanopatterning of metallic/semiconducting nanostructures, structural characterization (SEM, TEM, AFM).	
<b>FOR FURTHER READING</b>	
Basics and applications of electromagnetic spectrum - electronic, vibrational and rotational transitions. Principle, instrumentation -block diagram and applications of UV visible and IR spectroscopy.	
<b>1</b>	<b>3 Hours</b>
<b>EXPERIMENT 1</b>	
Determination of silica content in potassium silicate by titration methods	
<b>2</b>	<b>8 Hours</b>
<b>EXPERIMENT 2</b>	
(a) Preparation of conducting polymer by electro deposition method	
(b) Identification of functional group in conducting polymer compounds using IR spectroscopy.	
<b>3</b>	<b>4 Hours</b>
<b>EXPERIMENT 3</b>	
Interpretation of dielectric materials using DTA curve analysis	
<b>4</b>	<b>7 Hours</b>
<b>EXPERIMENT 4</b>	
(a) Estimation of Zn in ceramics using EDTA method	
(b) Comparison of different types of ceramics used in electrical/electronics by IR spectroscopy	
<b>5</b>	<b>4 Hours</b>
<b>EXPERIMENT 5</b>	
Preparation of CdS nanocrystals using thiourea	
<b>6</b>	<b>4 Hours</b>
<b>EXPERIMENT 6</b>	
Preparation of metal nanoparticles and their characterization	
<b>Total: 60 Hours</b>	

**Reference(s)**

1. Jain and Jain, Engineering Chemistry, 16th Edition, DhanpatRai Publishing Company, New Delhi, 2013.
2. R. Gowariker, N. V. Viswanathan, J. Sreedhar, Polymer Science, 1st Edition, New age International Publishers, New Delhi, 2014.
3. Sergio pizzini, Physical chemistry of semiconductor materials and processes, John Wiley & Sons, 2015.
4. T. Pradeep, Nano: The Essentials: Understanding Nanoscience and Nanotechnology, McGraw Hill, 2012.
5. George W. Hanson, Fundamentals of nano electronics, Prentice Hall, 2008.
6. Van Vleck Elements of Materials Science Addison Wesley Publishers, 2010. 7. Rolf. E, Hummel, Electronic Properties of Materials, 4ed. Springer, New York, 2011

**18EE204 BASICS OF CIVIL AND MECHANICAL****ENGINEERING****3 0 0 3****Course Objectives**

- To impart basic knowledge in the field of Civil Engineering.
- To create awareness on green building systems with its energy.
- To impart knowledge on various infrastructural systems.
- To familiarize students with all commonly used mechanical elements.
- To understand the working principles of various Internal Combustion Engines, Refrigeration and air conditioning.
- To impart knowledge on various types of Boilers and turbines.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Apply the site selection procedure for various building construction.
- Apply the green building and energy efficiency concept in a building construction.
- Analyse the infrastructural facility for indoor and outdoor applications.
- Apply the commonly known mechanical component and assemble the electrical appliances.
- Analyse the various Internal Combustion Engines and Refrigeration system and select the suitable one for the customer needs.
- Analyse the various Boilers and turbines for customized application.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
2	3	-	-	-	-	-	2	-	-	-	-	-	1	-
3	3	-	-	-	-	-	2	-	-	-	-	-	2	-
4	2	-	-	-	-	-	-	-	-	-	-	-	-	2
5	2	-	-	-	-	-	-	-	-	-	-	-	-	2
6	2	-	-	-	-	-	-	-	-	-	-	-	1	-

**UNIT I****7 Hours****BASIC REQUIREMENTS OF STRUCTURES**

Scope of Civil Engineering- Principles of Planning of buildings: orientation, energy efficiency, utility. Components of building-classification of buildings. Site selection for power plants, wind mill -Site measurements using chain and tape.

<b>UNIT II</b>	<b>7 Hours</b>
<b>GREEN BUILDINGS</b>	
Conventional versus green building delivery systems- LEED building assessment standard - LEED certification process - Building rating system in India and its future - Building energy issues - Building energy design strategies - Building envelope.	
<b>UNIT III</b>	<b>7 Hours</b>
<b>INFRASTRUCTURAL SYSTEMS</b>	
Water supply systems- Rain Water Harvesting Trenches. Classification of Highways- Types of bridges- Lighting of infrastructure facilities : indoor & outdoor.	
<b>UNIT IV</b>	<b>8 Hours</b>
<b>MECHANICAL ELEMENTS</b>	
Basic Concepts, Bearings - ball bearing, roller bearing, thrust bearing, taper roller bearing, journal / bush bearing, bearing blocks, one way bearings - Gears - spur, helical, bevel gear, worm gears, rack and pinion. Couplings - rigid coupling - sleeve, flange, clamp couplings. Flexible coupling - Oldham, universal, jaw and fluid couplings. Torque limiter - Belt drives - flat belt, V belt, timing belt drives. Chain drives, rope drives, chain block - Conveyers - roller conveyer, belt conveyer, vertical conveyer, pneumatic conveyer, chain conveyer, screw conveyer - Shafts, keys, spline shafts - Fasteners - screws, bolts, nuts and their specifications in mm and inch scale.	
<b>UNIT V</b>	<b>8 Hours</b>
<b>INTERNAL COMBUSTION ENGINES AND REFRIGERATION</b>	
Internal Combustion (IC) Classification, main components, working principle of two and four stroke petrol and diesel engines, differences Refrigeration working principle of vapour compression and absorption system. Introduction to Air conditioning.	
<b>UNIT VI</b>	<b>8 Hours</b>
<b>BOILERS AND TURBINE</b>	
Introduction to heat transfer - conduction, convection, radiation. Introduction to Boilers, classification, differences between fire tube and water tube boiler, super critical boiler. Steam turbines - working principle of single stage impulse and reaction turbine, Hydraulic turbine - working principle of Francis turbine, Kaplan turbine and Pelton wheel.	
	<b>Total: 45 Hours</b>
<b>Reference(s)</b>	
<ol style="list-style-type: none"> <li>1. N. Arunachalam, Basic of Civil Engineering, Pratheeba Publishers, 2000.</li> <li>2. M. Bauer, P. Mosle and M. Schwarz, Green Building: Guidebook for Sustainable Architecture, Springer - Verlag Berlin Heidelberg, 2010.</li> <li>3. Charles. J. Kibert, Sustainable Construction: Green Building Design and Delivery, John Wiley &amp; Sons, Inc., New Jersey, 2008.</li> <li>4. G. Shanmugam and M. S. Palanichamy, Basic Civil and Mechanical Engineering, Tata McGraw Hill Publishing Co., New Delhi, 2014.</li> <li>5. Traffic Engineering manual -2007. 6. <a href="http://www.sasurieengg.com/e-course-material/I-year-E-course-material-II-sem/9.GE6251-BCM.pdf">http://www.sasurieengg.com/e-course-material/I-year-E-course-material-II-sem/9.GE6251-BCM.pdf</a></li> <li>6. Basant C.M. Agrawal, Basic of Mechanical Engineering, Wiley India Pvt. Ltd., New Delhi 2014.</li> <li>7. V. B. Bhandari, Design of Machine Elements, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2010. V. Ganesan, Internal Combustion Engines, Tata McGraw Hill Publishing Company Private limited., New Delhi, 2012.</li> <li>8. R. K. Bansal, A Textbook of Fluid Mechanics and Machinery, Laxmi Publications (P) Ltd., New Delhi, Revised Ninth edition, 2014.</li> </ol>	

**18EE206 ELECTRIC CIRCUIT ANALYSIS****3 0 2 4****Course Objectives**

- To analyze the electric circuits using basic laws
- To compute electrical parameters like current and voltage using network theorems for AC and DC circuits
- To differentiate single phase and three phase circuits
- To analyze R, L, C components for resonance, coupling and transient response

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- 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.
- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 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.
- 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.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Apply the Kirchhoffs laws to the electric circuit to compute the electrical parameters.
- Apply the network theorems to compute various parameters of electric network.
- Analyze the three phase circuit with different types of loads to solve real-world electrical systems.
- Design a tank circuit for given frequency and analyze the coupled circuits for electrical networks.
- Analyze the transient response of RL, RC and RLC circuit to design the electrical system.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	1	2	-	-	-	2	-	2	1	3	-
2	3	3	-	2	1	-	-	-	-	2	2	1	3	-
3	3	3	-	2	1	-	-	-	2	-	-	1	3	-
4	3	3	2	2	1	-	-	-	-	-	-	1	3	1
5	3	3	-	2	2	-	-	-	-	2	-	1	2	-

<b>UNIT I</b>	<b>10 Hours</b>
<b>ELECTRIC CIRCUITS</b> Active and Passive elements - Ohm's law - Kirchhoff's Laws - Resistance in series and parallel -voltage division and current division - Mesh and Nodal analysis - Source Transformation - Generation of alternating emf - RMS value, average value, peak factor and form factor - Analysis of Pure Resistive, Inductive and Capacitive circuits	
<b>UNIT II</b>	<b>10 Hours</b>
<b>NETWORK THEOREMS FOR DC</b> Analysis of circuits using Thevenin' s theorem, Norton 's theorem, Maximum power transfer theorem and Superposition theorem - Applications.	
<b>UNIT III</b>	<b>8 Hours</b>
<b>THREE PHASE CIRCUITS</b> Introduction - Analysis of Three phase balanced and unbalanced systems with star and delta connected loads - Phasor diagram - Star-Delta transformation - Measurement of Power and Power factor.	
<b>UNIT IV</b>	<b>10 Hours</b>
<b>RESONANCE AND COUPLED CIRCUITS</b> Series and parallel resonance - Q factor and bandwidth - Resonant frequency of a tank circuit - Basics of magnetic circuits - Simple and Composite magnetic circuits - Self and Mutual inductances - Coefficient of Coupling - Coupled circuits - Dot convention - Coupled circuits in Series and Parallel.	
<b>UNIT V</b>	<b>7 Hours</b>
<b>TRANSIENTS</b> Steady state and Transient response - Transient Response of RL, RC and RLC Circuits with step and ramp input - Time Constant Analysis.	
<b>FOR FURTHER READING</b> Super Mesh and Super Node analysis - Reciprocity theorem - Millman' s Theorem - Two port networks.	
<b>1</b>	<b>6 Hours</b>
<b>EXPERIMENT 1</b> Experimental verification of Kirchhoff's voltage and current laws.	
<b>2</b>	<b>6 Hours</b>
<b>EXPERIMENT 2</b> Experimental verification of Thevenin's and Norton Theorem.	
<b>3</b>	<b>6 Hours</b>
<b>EXPERIMENT 3</b> Study of CRO and measurement of voltage and frequency using function generator.	
<b>4</b>	<b>6 Hours</b>
<b>EXPERIMENT 4</b> Experimental determination of power in three phase circuits by two-watt meter method.	
<b>5</b>	<b>6 Hours</b>
<b>EXPERIMENT 5</b> Frequency Response of a series R-L-C Circuit	
	<b>Total: 75 Hours</b>

**Reference(s)**

1. William H. Hayt, Jack E. Kemmerly, and Steven M. Durbin, Engineering Circuit Analysis, Eighth Edition, Tata McGraw Hill, 2013.
2. Charles K. Alexander, Fundamentals of Electric Circuits, Fifth Edition, Tata McGraw Hill Publishing Co Ltd, 2013.
3. Mahmood Nahvi, Joseph A Edminister, Electric Circuits, Fifth Edition, Tata McGraw Hill Publishing Company Limited, 2017.
4. S P Ghosh, A K Chakraborty, Network Analysis and Synthesis, Tata McGraw Hill Education Private Limited, 2010.
5. Sudhakar and S. P. Shyam Mohan, Circuits and Network Analysis and Synthesis, Fifth Edition, Tata McGraw Hill, 2015.

**18EE207 ENGINEERING GRAPHICS****1 0 4 3****Course Objectives**

- Provide knowledge on projection of points and lines.
- Impart skill in drawing projection of simple solids.
- Familiarize creation of orthographic views from isometric projections of simple solids and vice versa.
- Build the proficiency to create two dimensional sketches using software.
- Provide the skill to build three dimensional models and its orthographic views using software.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

**Course Outcomes (COs)**

- Analyse the projection of points and lines in different quadrants.
- Construct orthographic projections of simple solids.
- Create the orthographic and isometric projections of simple solids.
- Develop the two dimensional views of engineering components using software.
- Construct three dimensional models of engineering components and its orthographic views using software.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	-	-	-	-	-	-	-	2	-	-	-	1	-
2	2	-	-	-	-	-	-	-	2	-	-	-	2	-
3	2	-	-	-	-	-	-	-	2	-	-	-	1	-
4	2	-	-	-	-	-	-	-	2	-	-	-	3	-
5	2	-	-	-	-	-	-	-	2	-	-	-	3	-

**UNIT I****3 Hours****PROJECTION OF POINTS AND LINES**

Practices on lettering, numbering and dimensioning of drawings. Principles of projection, Projection of points in four quadrants, first angle projection of straight lines - parallel, perpendicular and inclined to anyone plane.

**UNIT II****3 Hours****PROJECTION OF SOLIDS**

Orthographic projection of simple solids - parallel, perpendicular and inclined to one plane using change of position method.

**UNIT III****3 Hours****ISOMETRIC AND PERSPECTIVE PROJECTION**

Conversion of isometric to orthographic projection and vice versa. Perspective projection of simple solids.

**UNIT IV****3 Hours****CREATION OF 2D SKETCHES USING SOFTWARE**

Sketch Entities - line, circle, arc, rectangle, slots, polygon, text, snap, and grid. Sketch Tools-fillet, chamfer, offset, convert entities, trim, extend, mirror, move, copy, rotate, scale, stretch, sketch pattern. Geometrical constraints, Dimensioning - smart, horizontal, vertical, ordinate

**UNIT V****3 Hours****PART MODELING AND DRAFTING USING SOFTWARE**

Part Modeling - extrude, cut, revolve, creation of planes, fillet, chamfer, shell, rib, pattern, mirror, loft, draft and swept. Drafting - Converting 3D models to orthographic views with dimensions.

**1****12 Hours****EXPERIMENT 1**

Create 2D sketch of different components used in engineering applications.

**2****12 Hours****EXPERIMENT 2**

Create part model of a component from given isometric drawings.

**3****12 Hours****EXPERIMENT 3**

Create part model of a component from given orthographic views.

**4****12 Hours****EXPERIMENT 4**

Create an assembly model of product from detailed parts drawing.

**5****12 Hours****EXPERIMENT 5**

Create stl file from CAD model, transfer file to 3D printer, setup the machine parameters, build and post process the component using Additive Manufacturing Technology.

**Total: 75 Hours****Reference(s)**

1. K Venugopal, Engineering Drawing and Graphics, Third edition, New Age International, 2005.
2. Basant Agrawal, Mechanical drawing, Tata McGraw-Hill Education, 2008.
3. Engineering Drawing Practice for Schools & Colleges, Bureau of Indian Standards-Sp46, 2008.
4. N. D. Bhatt and V. M. Panchal, Engineering Drawing, Charotar Publishing House Pvt. Limited, 2008.
5. K.V. Natarajan, A Text Book of Engineering Graphics, Dhanalakshmi Publishers, 2013.
6. Ian Gibson, David W Rosen, Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010

**18EE301 ENGINEERING MATHEMATICS III****3 1 0 4****Course Objectives**

- Understand the concepts of Fourier series, Transforms and Boundary Conditions, which will enable them to model and analyze the physical phenomena
- Implement the Fourier analysis, an elegant method in the study of heat flow, fluid mechanics and electromagnetic fields.
- Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

**Course Outcomes (COs)**

1. Apply the Fourier series concepts to analyse the harmonics
2. Apply the Fourier transform technique to develop a filter
3. Apply Laplace transform and deduce transfer function
4. Apply the Z-transform to convert a discrete-time signal, which is a sequence of real or complex numbers, into a complex frequency domain representation.
5. Apply basic statistical inference techniques, including confidence intervals, hypothesis testing to science/engineering problems.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	-	-	-	-	-	-	-	-	-	-	3	-
2	3	3	-	-	-	-	-	-	-	-	-	-	3	-
3	3	3	-	-	-	-	-	-	-	-	-	-	2	-
4	2	2	-	-	-	-	-	-	-	-	-	-	2	-
5	2	2	-	-	-	-	-	-	-	-	-	-	2	-

**UNIT I****9 Hours****FOURIER SERIES**

Dirichlet's conditions - General Fourier series - Odd and even functions - Half range cosine and sine series - Root mean square value- Harmonic analysis

**UNIT II****9 Hours****FOURIER TRANSFORM**

Fourier Integral Theorem- Fourier Transform and Inverse Fourier Transform- Sine and Cosine Transforms - Properties - Transforms of Simple Functions - Convolution Theorem - Parseval's Identity

**UNIT III****9 Hours****LAPLACE TRANSFORM**

Properties and theorems of Laplace transform - Shifting theorems- Inverse Laplace transforms -

Convolution Applications to ordinary differential equations - Applications to linear system analysis.

**UNIT IV**

**9 Hours**

**Z -TRANSFORM**

Z-Transform - Elementary Properties - Inverse Z-Transform - Convolution Method- Partial fraction method - Solution of Difference Equations using Z-Transform.

**UNIT V**

**9 Hours**

**PARTIAL DIFFERENTIAL EQUATION**

Introduction to partial differential equations, One-dimensional wave equation, Method of separation of variables, D'Alembert's solution of the wave equation - Heat equation, Laplace's equation , Laplace transform method of solution.

**Total: 60 Hours**

**Reference(s)**

1. Kreyszig Erwin, Advanced Engineering Mathematics, 10 Edition, John Wiley, 2015.
2. Johnson Richard A. and Bhattacharyya Gouri K., Statistics, Principles and Methods, 7th Edition, John Wiley, 2014.
3. O'Neil Peter V., Advanced Engineering Mathematics, 4th Edition, PWS-Kent, 1997.
4. James Glyn, Advanced Modern Engineering Mathematics, Addison-Wesley, 4th edition 2011.
5. Greenberg Michael D., Advanced Engineering Mathematics, Prentice-Hall International Inc, 2nd Edition 2006.

**18EE302 ELECTRON DEVICES AND CIRCUITS****3 0 0 3****Course Objectives**

- To understand the construction, operation and characteristics of solid state switching devices.
- To understand the operation of voltage amplifiers
- To analyze the performance of power amplifiers and feedback amplifiers.
- To understand the construction and operation of oscillators and multivibrators.
- To analyze the performance of wave shaping circuits

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Analyze the characteristics of semiconductor devices to select suitable device for specific applications.
- Analyze the principles of BJT in RC-coupled amplifiers and differential amplifiers to evaluate their performance in different electronic circuits.
- Analyze the performance of power and feedback amplifiers for industrial applications.
- Apply the Oscillator and Multivibrator circuits for waveform generation.
- Analyze the rectifiers and voltage regulator for designing power supply.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
2	2	2	2	2	-	-	-	-	-	-	-	-	2	2
3	2	2	1	2	-	-	-	-	-	-	-	-	2	2
4	2	1	1	2	-	-	-	-	-	-	-	-	2	2
5	2	2	1	2	-	-	-	-	-	-	-	-	2	3

**UNIT I****8 Hours****SEMICONDUCTOR DEVICES**

Construction, Operation and characteristics of PN Junction Diode, Zener diode, BJT, MOSFET and UJT, Photodiode, Photo Transistor, LED.

**UNIT II** **8 Hours**

**VOLTAGE AMPLIFIERS**

Biassing of BJT-RC Coupled Amplifier - Differential amplifier using BJT -Differential and Common mode gain, CMRR

**UNIT III** **9 Hours**

**POWER AND FEEDBACK AMPLIFIERS**

Performance analysis of Class A, Class B, Class C and Class D - Basic concepts of feedback amplifiers- Topologies - Effect of negative feedback on input and output resistances, gain stability, distortion, bandwidth.

**UNIT IV** **10 Hours**

**OSCILLATOR AND MULTIVIBRATORS**

Oscillators, Barkhausen Criterion, RC phase shift oscillators, Wien Bridge and Hartley oscillators, Colpitts oscillators and UJT based saw tooth oscillator, Astable, Monostable, Bistable Multivibrators - operation.

**UNIT V** **10 Hours**

**POWER SUPPLY AND WAVESHAPING CIRCUITS**

Performance analysis Half wave rectifier and full wave rectifier, Filters -Series and Shunt Voltage Regulator - Clippers and Clampers.

**Total: 45 Hours**

**Reference(s)**

1. Jacob. Millman, Christos C.Halkias, Electronic Devices and Circuits, 3rd Edition ,Tata McGraw Hill Publishing Limited, New Delhi.
2. David A. Bell, Electronic Devices and Circuits,5th Edition,Oxford University Press,
3. N.P.Deshpande, Electronic Devices and Circuits,1stEdition,Tata McGraw Hill Publishing Limited, New Delhi,2013.
4. Thomas L Floyd, Electronic Devices, Prentice Hall of India, New Delhi,2011.

**18EE303 ELECTRICAL MACHINES I****3 1 0 4****Course Objectives**

- To understand the production of torque and EMF.
- To understand the construction, operation and characteristics of various types of DC machines.
- To understand the operation and performance of special machines
- To understand the construction, operation and characteristics of transformers
- To estimate the performance of Transformers.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Apply the concept of Magnetic circuit in electro-mechanical energy conversion systems.
- Analyze the characteristics of DC Generators and motors.
- Analyze the performance of special electrical machines for industrial applications.
- Analyze the performance of the transformers using equivalent circuit.
- Estimate the losses and regulation of transformers through suitable testing methods.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	-	-	-	-	-	-	-	-	-	-	3	-
2	2	3	-	-	-	-	-	-	-	-	-	-	2	-
3	2	1	-	-	-	-	-	-	-	-	-	-	-	3
4	2	2	-	-	-	-	-	-	-	-	-	-	3	-
5	3	3	-	3	-	-	-	-	-	-	-	-	3	-

**UNIT I****8 Hours****PRINCIPLES OF ENERGY CONVERSION**

Faraday's law of electromagnetic induction -singly and doubly excited magnetic field systems -EMF and torque production in rotating machines.

**UNIT II****12 Hours****DC MACHINES**

Generator and Motor- Construction - Principle of operation - Types - Characteristics - Armature reaction and commutation - Starting and Speed control -Various testing-Braking -Applications

**UNIT III****8 Hours****SPECIAL MACHINES**

Stepper motor, permanent magnet brushless D.C. motor and switched reluctance motors -construction-principle of operation-types- applications

**UNIT IV**

**9 Hours**

**TRANSFORMERS**

Construction - Principle of operation - Types - Equivalent circuit -Voltage regulation and efficiency - Auto transformer

**UNIT V**

**8 Hours**

**TRANSFORMER TESTING**

Testing of transformers -Polarity, open circuit, short circuit and Sumpner's test - Three phase transformers connections- Parallel operation

**Total: 60 Hours**

**Reference(s)**

1. D. P. Kothari and I. J. Nagrath, Electric Machines, Tata McGraw Hill Publishing Company Ltd, 2017
2. P. S. Bimbhra, Electrical Machinery, Khanna Publishers, Delhi, 2018
3. E. Fitzgerald, Charles Kingsley, Stephen.D.Umans, Electric Machinery, Tata McGraw Hill publishing Company Ltd, New Delhi ,2015
4. Stephen J.Chapman, Electric Machinery Fundamentals, Tata McGraw Hill, New Delhi, 2018.
5. T.Kenjo, Stepping motors and their microprocessor controls, Oxford University press, New Delhi, 2011
6. T.Kenjo and S.Nagamori,Permanent magnet and Brushless DC motors, Clarendon press, London, 2015

**18EE304 ELECTROMAGNETIC THEORY****3 1 0 4****Course Objectives**

- To understand the application of vector calculus in electromagnetic theory.
- To understand the concept of Coulombs law and Gauss law.
- To calculate magnetic density and magnetic field intensity using Biot-savart law and amperes law.
- To compute Maxwell's equations using Faraday's Law, Gauss Law and Amperes law.
- To examine Electromagnetic wave propagation in different medium.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Apply coordinate systems and vector calculus concepts to solve engineering problems.
- Apply Coulomb's Law and Gauss Law to compute electric potential and electric flux density.
- Apply Biot-savart Law and Ampere's Law to find Magnetic potential.
- Apply Faraday's laws, Maxwell's equations, and the Poynting theorem to solve the electromagnetic problems
- Analyze the parameters of electromagnetic wave propagation in different medium and wave parameters.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	-	-	-	-	-	-	-	-	-	-	2	-
2	3	3	-	-	-	-	-	-	-	-	-	-	2	-
3	3	3	-	-	-	-	-	-	-	-	-	-	2	-
4	3	3	-	-	-	-	-	-	-	-	-	-	3	1
5	3	3	-	-	-	-	-	-	-	-	-	-	3	1

**UNIT I****10 Hours****INTRODUCTION**

Different co-ordinate systems: Cartesian coordinates, cylindrical coordinates, spherical coordinates - Vector calculus: Differential length, area and volume, line surface and volume integrals - gradient of a scalar, divergence of a vector and divergence theorem - curl of a vector and Stoke's theorem - Laplacian of a scalar.

**UNIT II****10 Hours****ELECTROSTATICS**

Coulomb's Law - Electric field intensity - Field due to point and continuous charges - Gauss's law and it's applications to calculate electric field - Electric scalar potential - Polarization-Boundary conditions- Poisson's and Laplace's equations - Capacitance-energy density.

**UNIT III** **9 Hours**

**MAGNETOSTATICS**

Magnetic field intensity - Biot-savart Law - Ampere's Law - Magnetic field due to straight conductors, circular loop, infinite sheet carrying current -Magnetization-Boundary Conditions-Magnetic vector potential.

**UNIT IV** **8 Hours**

**ELECTRODYNAMICFIELDS**

Faraday's laws, induced EMF - Static and dynamic EMF, Maxwell's equations (differential and integral forms), Poynting theorem.

**UNIT V** **8 Hours**

**ELECTROMAGNETIC WAVES**

Electro Magnetic Wave equations - Wave parameters: velocity, intrinsic impedance, propagation constant - Waves in free space - skin depth.

**Total: 60 Hours**

**Reference(s)**

1. William H. Hayt, Jr. John A. Buck, Engineering Electromagnetics, McGraw Hill Higher Education, 8th revised Edition, 2011.
2. K. A. Gangadhar, P.M. Ramanathan, Electromagnetic Field Theory, Khanna Publishers, Sixteenth Edition, 2011.
3. Bhag Sing Guru and Huseyin R. Hiziroglu, Electromagnetic Field Theory Fundamentals, Cambridge University Press, fourth Edition, 2010.
4. A. Joseph. Edminister and Vishnu Priye, Electromagnetics, Special Indian edition, Schaum's Outlines, Tata McGraw Hill, 2009.
5. Sadiku, Elements of Electromagnetics, Third Edition, Oxford University Press, 2010.
6. Kraus and Fleish, Electromagnetics with Applications, McGraw Hill International Editions, Fifth Edition, 2008.

**18EE305 POWER GENERATION SYSTEMS****3 0 0 3****Course Objectives**

- To understand the various terminologies of power plants
- To understand the layout and working of steam power station
- To understand the layout and working of hydro power station
- To understand the layout and main parts of nuclear power station
- To understand the working of different types of alternative sources of electrical energy

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- 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.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Analyze the performance parameters of power plants and select appropriate power stations.
- Assess the characteristics of turbo alternators and functions of steamturbines for thermal power plant.
- Use hydrological data and analyze the functional aspects of hydroelectric power station.
- Analyze the layout, working and site selection criteria of Nuclear power station
- Apply the concepts of alternative energy sources for sustainable energy solutions

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	-	-	-	-	2	-	-	-	2	-	2	-
2	3	-	-	-	-	2	2	2	-	-	-	1	2	1
3	3	-	-	-	-	2	2	-	-	-	-	1	2	1
4	3	-	-	-	-	2	2	-	-	-	-	1	2	1
5	3	-	-	-	-	2	3	2	-	-	-	1	2	1

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

Connected load, maximum load, maximum demand, demand factor, load factor, diversity factor, plant capacity factor, plant utilization factor, load curve, load duration curve and mass curve. Choice of Power station and units.

**UNIT II** **9 Hours**

**STEAM POWER STATION**

Steam station layout, Steam station auxiliaries and working of a steam station, characteristics of turbo alternators, super pressure steam stations and Cogeneration systems.

**UNIT III** **8 Hours**

**HYDRO POWER STATION**

Hydrology, Hydrographs, Flow duration curve, Hydroelectric power plants - classification, Layout, auxiliaries and working of a hydro station.

**UNIT IV** **9 Hours**

**NUCLEAR POWER STATIONS**

Basics of nuclear energy, Layout and main parts of nuclear power station, types of reactor, site selection criteria for nuclear power plant, safety measures.

**UNIT V** **10 Hours**

**ALTERNATIVE SOURCES OF ENERGY**

Solar power generation - Photo-voltaic and solar thermal generation, Wind power generation, Geo Thermal, Biomass, Fuel Cell power systems, micro-hydel power plants, tidal power generation and MHD generation.

**FOR FURTHER READING**

Types of power station, Types of dam, Types of power reactor, Conversion of solar energy into electric energy.

**Total:45 Hours**

**Reference(s)**

1. B.R. Gupta Generation of Electrical Energy, S.Chand Publishers, New Delhi,2015.
2. J.B.Gupta , A Course in Electrical Power, S.K. Kataria & Sons Publishers, New Delhi ,2014.
3. Gate Academy Publication, Electrical Power Generation, Third Edition, DURG, 2016.
4. M.V. Deshpande ,Elements of Electric Power Station Design, Tata McGraw Hill, New Delhi ,2006.
5. Car, T.H., Electric Power Station, Chappman& Hall Publishers, 2006.
6. Soni Gupta Bhatnagar , A Course in Electrical Power, DhanpatRai Publishers, New Delhi ,2009.

**18EE306 COMPUTER PROGRAMMING II****3 0 2 4****Course Objectives**

- Understand the fundamental concepts of data structure
- Impart the different paradigms in linear and non-linear data structures to problem solutions
- Determine the problems to solve using sorting and searching algorithms

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- 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.
- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
- Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 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.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

**Course Outcomes (COs)**

1. Compute the time and space complexity of algorithms with asymptotic notations.
2. Develop applications using stack and queue data structures.
3. Implement all the operations of linked list data structures to store and retrieve the given data.
4. Construct a hierarchical data structure to represent the given data using tree data structure.
5. Analyze the efficiency of various searching and sorting techniques using different data structures.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	2	3	-	-	1	2	2	-	2	1	-
2	2	3	2	2	3	-	-	1	2	2	-	2	2	-
3	2	3	2	2	3	-	-	1	2	2	-	2	3	-
4	2	3	2	2	3	-	-	1	2	2	-	2	3	-
5	2	2	3	2	3	-	-	1	2	2	-	2	3	-

Basic Terminologies: Elementary Data Organizations, Data Structure Operations: Insertion, Deletion, Traversal, Analysis of an Algorithm: Asymptotic Notations, Time-Space Trade off, Abstract Data Types (ADTs): List ADT

**UNIT II** **9 Hours**

**STACKS AND QUEUES**

ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation-corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.

**UNIT III** **9 Hours**

**LINKED LIST**

Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.

**UNIT IV** **10 Hours**

**TREES**

Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with Complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis.

**UNIT V** **8 Hours**

**SORTING AND HASHING**

Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing.

**FOR FURTHER READING**

Applications of list - Red-Black trees - Splay trees- Bucket hashing - Introduction to NP Completeness

**1** **3 Hours**

**EXPERIMENT 1**

Implement the concepts of Stack, Simple Queue using Arrays

**2**

**EXPERIMENT 2**

Implement the concepts of Circular Queue and Priority Queue ADT using Arrays

**3** **3 Hours**

**EXPERIMENT 3**

Implement Singly and Doubly Linked list.

**4** **3 Hours**

**EXPERIMENT 4**

Implement Circular Linked list

**5** **3 Hours**

**EXPERIMENT 5**

Implement Stack and Queue ADT using Linked list

**6** **3 Hours**

**EXPERIMENT 6**

Create program to perform tree traversals and other operations in a Binary Search Tree

**7** **3 Hours**

**EXPERIMENT 7**

Develop applications for Hashing.

**8**

**3 Hours**

**EXPERIMENT 8**

Implement Sorting and Searching algorithms based on a given scenario.

**9**

**3 Hours**

**EXPERIMENT 9**

Implement Quick sort and Merge sort based on a given scenario

**10**

**3 Hours**

**EXPERIMENT 10**

Implement Heap sort based on a given scenario

**Total: 75 Hours**

**Reference(s)**

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Pearson Education,2016.
2. Ellis Horowitz, Sartaj Sahni,Fundamentals of Data Structures, Illustrated Edition, Computer Science Press.
3. Richard F. Gilberg, and Behrouz A. Forouzan, Data Structures - A Pseudocode Approach with C, Thomson 2011.
4. R. G. Dromey,How to Solve it by Computer, 2nd Impression, Pearson Education.

**18EE307 ELECTRICAL MACHINES I LABORATORY****0 0 2 1****Course Objectives**

- To understand the characteristics of DC motor under various loading conditions.
- To understand the open circuit and load characteristics of DC generator
- To perform the tests to determine the efficiency and regulation of the DC machines and transformers

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- 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.
- 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.
- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Analyze the performance characteristics of DC motors and generators under defined conditions.
- Analyze the efficiency and speed control methods of DC shunt motor for industrial applications.
- Analyze the performance of DC machine by conducting suitable tests.
- Analyze the operation of stepper motors by implementing specific excitation schemes to achieve precise and controlled movements.
- Apply various tests to determine and optimize the performance parameters of single-phase transformers.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	-	2	2	-	-	-	-	2	2	-	-	3	-
2	3	-	3	3	-	-	-	-	2	2	-	-	2	-
3	3	-	3	2	-	-	-	-	2	2	-	-	2	2
4	2	-	3	3	-	-	-	-	2	2	-	-	3	2
5	3	-	-	2	-	-	-	-	2	2	-	-	1	3

**1****3 Hours****EXPERIMENT 1**

Performance Analysis of Permanent Magnet DC motor

**2****3 Hours****EXPERIMENT 2**

Performance Analysis of DC Generator coupled with DC motor

**3****3 Hours****EXPERIMENT 3**

Control of Permanent Magnet DC motor.

4	<b>EXPERIMENT 4</b> Load test on DC shunt motor .	3 Hours
5	<b>EXPERIMENT 5</b> Speed control of DC shunt Motor.	3 Hours
6	<b>EXPERIMENT 6</b> Predetermination of Efficiency of DC machine using Swinburne’s Test.	3 Hours
7	<b>EXPERIMENT 7</b> Control of stepper motor for different excitations.	3 Hours
8	<b>EXPERIMENT 8</b> Load test on single phase transformer.	3 Hours
9	<b>EXPERIMENT 9</b>  Open circuit and short circuit test on single phase transformer.	3 Hours
10	<b>EXPERIMENT 9</b> Determination of performance parameters of transformer using Sumpner’s test.	3 Hours

**Total: 30 Hours**

### **18EE308 ELECTRON DEVICES AND CIRCUITS LABORATORY**

**Course Objectives**

**0 0 2 1**

- To obtain the VI characteristics of semiconductor devices.
- To construct a regulated DC power supply for various voltage level.
- To obtain the frequency response of amplifiers and oscillator circuits.

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- j. 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.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

n. Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

### Course Outcomes (COs)

1. Analyze the Volt-Ampere characteristics of diodes, current controlled and voltage controlled power switches.
2. Design and implement a gate driver circuit for Power Switches.
3. Design and implement the Power supply circuits using voltage regulators.
4. Design and analyse the performance of amplifiers and oscillators
5. Design and implementation of Monostable and Astable Multivibrator circuits.

### Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	3	-	-	-	-	-	2	2	-	-	3	-
2	1	2	3	-	-	-	-	-	2	2	-	-	3	2
3	3	2	3	-	-	-	-	-	2	2	-	-	3	2
4	3	2	3	-	-	-	-	-	2	2	-	-	3	2
5	1	2	3	-	-	-	-	-	2	2	-	-	3	3

**1** **4 Hours**

#### **EXPERIMENT 1**

Volt-Ampere characteristics of PN diode and Zener diode.

**2** **4 Hours**

#### **EXPERIMENT 2**

Volt-Ampere characteristics of Transistor and MOSFET.

**3** **4 Hours**

#### **EXPERIMENT 3**

Design of Gate driver circuit for MOSFET

**4** **2 Hours**

#### **EXPERIMENT 4**

Design of DC Power supply circuit.

**5** **2 Hours**

#### **EXPERIMENT 5**

Design and verification of series voltage regulator.

**6** **2 Hours**

#### **EXPERIMENT 6**

Design and implementation of CE amplifier.

**7** **2 Hours**

#### **EXPERIMENT 7**

Design and implementation of class B push pull amplifier.

**8** **4 Hours**

#### **EXPERIMENT 8**

Design and implementation of RC Phase shift and Wein bridge oscillator.

**9** **4 Hours**

#### **EXPERIMENT 9**

Design and implementation of Monostable and Astable Multivibrator circuits.

**10**

**2 Hours**

**EXPERIMENT 10**

Design of audio amplifier using any one type of power amplifier.

**Total: 30 Hours**

**18EE401 GRAPH THEORY AND PROBABILITY****3 1 0 4****Course Objectives**

- Understand the basic concepts of probability and the distributions with characteristics of one dimensional random variables.
- Analyze the various data by different numerical and statistical sampling techniques.
- Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
  - Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
  - Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

**Course Outcomes (COs)**

- Demonstrate and apply the basic probability axioms and concepts in their core areas of random phenomena.
- Analyze the various data by different numerical techniques.
- Analyze the various collection of data in science / engineering problems using statistical inference techniques.
- Apply the stastics process to train the neural networks.
- Apply the concept of error analysis and finite element analysis techniques in their core area

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	-	-	-	-	-	-	-	-	1	2	-
2	3	1	-	-	-	-	-	-	-	-	-	1	3	-
3	1	1	-	-	-	-	-	-	-	-	-	1	1	-
4	1	1	-	-	-	-	-	-	-	-	-	1	1	-
5	2	3	-	-	-	-	-	-	-	-	-	3	2	-

**UNIT I****10 Hours****GRAPH THEORY**

Introduction to Graphs-Graph operations- Graph and Matrices-Graph Isomorphism- Connected Graphs- Euler Graphs- Hamilton paths and circuits- planar Graph-Graph colouring-Trees- Shortest path problem.

**UNIT II****9 Hours****NUMERICAL SOLUTIONS OF DIFFERENTIAL EQUATION**

Solution of first order ordinary differential equations: Euler and Modified Euler methods-Fourth order Runge- Kutta method - Solution of partial differential equations: Elliptic equations: Laplace equation and Poisson's equation.

**UNIT III****10 Hours****PROBABILITY THEORY**

Probability. Random variables, probability densities and distributions, mean and variance of a

distribution. Conditional probability. Bayes theorem. Binomial, Poisson and normal distributions.

**UNIT IV**

**9 Hours**

**STATISTICS**

Mean: Arithmetic mean ,Geometric mean and Harmonic mean ,Median, Mode, Variance, Standard Deviation, Time series Analysis: Moving average Techniques, Covariance, Correlation and Regression.

**UNIT V**

**7 Hours**

**ERROR ANALYSIS**

Errors, Truncation and round off errors, measurement errors, Chebyshev's Polynomial and data filtering.

**Total: 60 Hours**

**Reference(s)**

- 1 Greenberg Michael D., Advanced Engineering Mathematics, Prentice-Hall International Inc,2nd Edition 2006.
- 2 James Glyn, Advanced Modern Engineering Mathematics, Addison-Wesley, 4th Edition 2011.
- 3 Kreyszig Erwin, Advanced Engineering Mathematics, 10th Edition, John Wiley, 2015.
- 4 Kenneth H Rosen, Discrete Mathematics and its Applications with Combinatorics and Graph Theory, Seventh Edition, Seventh Edition, Mc Graw Hill Education India Private Limited, New Delhi, 2013.
- 5 Milton J. S. and Arnold Jesse C., Introduction to Probability and Statistics: Principles and Applications for Engineering and the Computing Sciences, McGraw Hill Inc, 4th Edition, 2002.

**18EE402 DIGITAL LOGIC CIRCUITS****3 1 0 4****Course Objectives**

- To perform the numeric conversions and design of simple logic circuits.
- To understand the concepts of combinational circuits
- To construct synchronous and asynchronous sequential circuits
- To familiarize with programmable logic devices and logic families
- To understand the fundamental concepts of VHDL programming

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
  - Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - 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.
  - 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.
  - Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- 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.
  - Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
  - Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Apply Boolean algebra and number systems to design the digital circuits.
- Design and realize the combinational circuits using logic gates for data processing.
- Analyze the synchronous and asynchronous sequential circuits using basic flip flops.
- Examine the operation of various Programmable Logic Devices and logic families to develop efficient digital systems.
- Develop simple programs in VHDL for suitable applications.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	3	1	-	-	-	-	-	-	-	2	3	-
2	3	2	3	1	-	-	-	-	-	-	-	2	3	1
3	3	2	3	1	-	-	-	-	-	-	-	2	3	1
4	3	2	3	1	-	-	-	-	-	-	-	2	2	1
5	3	2	-	-	3	-	-	-	-	-	-	2	2	1

**UNIT I**

**10 Hours**

**NUMBER SYSTEM AND BOOLEAN ALGEBRA**

Review of number system; Types and conversion of codes-BCD, Gray code, Excess 3 code; Error detection and correction codes; Boolean algebra: De-Morgan's theorem, Simplification of functions using K-maps- Quine McCluskey method.

**UNIT II**

**9 Hours**

**COMBINATIONAL CIRCUITS**

Design of functions using logic gates, Design of Adders, Subtractors, Comparators, Code converters, Encoders, Decoders, Multiplexers and Demultiplexers.

**UNIT III**

**10 Hours**

**SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS**

Flip flops - SR, JK - MSJK , D and T, Analysis of synchronous and asynchronous sequential circuits, Design of synchronous sequential circuits-Counters, Moore and Melay model; state diagram; state reduction; state assignment.

**UNIT IV**

**7 Hours**

**PROGRAMMABLE LOGIC DEVICES AND LOGIC FAMILIES**

Programmable Logic Devices: PLA, PAL, Logic families: TTL, ECL,IIL, CMOS.

**UNIT V**

**9 Hours**

**INTRODUCTION TO VHDL**

Digital design process flow- Entities and Architecture-Concurrent statements-Sequential statements - Behavioral, Dataflow, and structural modeling - simple VHDL codes.

**FOR FURTHER READING**

Shift registers: shift register operations, SISO, SIPO, PISO and PIPO, Design of asynchronous sequential circuits, Field Programmable Logic Array(FPLA)

**Total: 60 Hours**

**Reference(s)**

1. Malvino and Leach, Digital Principles and Applications, Tata McGraw Hill, New Delhi, 7th edition, 2011
2. A.Anand kumar, Fundamentals of digital circuits, 3rd Edition, PHI Learning Pvt Ltd, 2014
3. John M. Yarbrough, Digital Logic, Application & Design, Thomson, 2010.
4. Floyd, Digital Fundamentals, Pearson Education, 10 th edition, 2011.
5. M. Morris Mano, Digital Logic and Computer Design, Prentice Hall of India, 4th edition, 2013
6. A. K. Maini, Digital Electronics: Principles, Devices And Applications, Wiley, 2007

## 18EE403 TRANSMISSION , DISTRIBUTION

### AND UTILIZATION

3 0 0 3

#### Course Objectives

- To understand the various types of transmission system and develop the mathematical models for line parameters.
- To compute the voltage regulation and efficiency using line parameters.
- To analyze the voltage distribution in insulator strings and grading of cables in transmission lines.
- To understand the different types of distribution system and substations with its layout
- To understand the application of electrical energy in domestic and industrial loads.

#### Programme Outcomes (POs)

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- d. 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.
- f. 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.
- g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- k. 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.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

#### Course Outcomes (COs)

1. Evaluate the fundamental parameters of overhead transmission line for transmission line modeling.
2. Apply transmission line equation and phasor diagram to estimate the voltage regulation and efficiency of short, medium, and long transmission lines under various load conditions.
3. Analyze the characteristics of different types of cables and insulators and estimate the string efficiency of insulators.
4. Analyze the layout of primary and secondary AC distribution system for power distribution.
5. Select the suitable electrical heating and welding techniques for industrial application.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
1	3	2	-	2	-	2	2	-	-	-	2	-	3	-
2	3	2	-	2	-	-	-	-	-	-	2	-	3	-
3	3	1	-	-	-	-	-	-	-	-	2	-	1	-
4	3	-	-	-	-	2	2	-	-	-	-	-	-	1
5	3	-	-	-	-	2	2	-	-	-	-	-	-	1

**10 Hours****UNIT I****LINE PARAMETERS**

Resistance, Inductance and capacitance of single phase and three phase line - Stranded and bundled conductor configurations - Symmetrical and unsymmetrical spacing - Transposition of line conductors - Double circuit lines - Skin and proximity effects.

**UNIT II****10 Hours****PERFORMANCE OF TRANSMISSION LINES**

Regulations and Efficiency of Short Lines, Medium transmission lines by nominal T &  $\bar{Z}$  methods- Long Transmission line by Rigorous Solutions - ABCD Constant - Ferranti Effect - Corona Effect - Corona loss.

**UNIT III****8 Hours****CABLES AND INSULATORS**

Cables - Types - Capacitance - Grading of cables - Testing of cables - Insulators - Types and comparison - Voltage distribution in insulator string - String efficiency - Methods of improving string efficiency.

**UNIT IV****9 Hours****DISTRIBUTION SYSTEM**

AC distribution - single phase and three phase, 4-wire distribution- System comparison- Primary and Secondary distribution networks - Underground Distribution system - Laying, Terminal equipment - Substation equipment and layouts.

**UNIT V****8 Hours****UTILIZATION OF ELECTRICAL ENERGY**

Electric Heating: Advantages and methods of electric heating, resistance heating, induction heating and dielectric heating Electric Welding: resistance and arc welding, electric welding equipment, comparison between A.C. and D.C. Welding.

**Total: 45 Hours****Reference(s)**

1. C.L. Wadhwa, Electrical Power Systems, New Age International Edition, New Delhi 2018
2. I.J.Nagrath, D.P.Kothari, Power System Engineering, Tata McGraw Hill Ltd, New Delhi, 2017
3. V. Kamaraju, Electrical Power Distribution Systems, Tata McGraw Hill Ltd, New Delhi, 2017
4. Turan Gonen, Electric Power Distribution system, Engineering, CRC Press 2017
5. H Partap Art and Science of Utilization of Electrical Energy, Dhanpat Rai & Sons 2017
6. E. Openshaw Taylor and V. V. L. Rao, Utilization of Electric Energy, University Press

**18EE404 ELECTRICAL MACHINES II****3 1 0 4****Course Objectives**

- To understand the construction, working and performance characteristics of alternator.
- To understand the construction and starting methods of Synchronous motor.
- To understand the construction working and performance characteristics of single phase and three phase induction motor.
- To select the appropriate machine from the knowledge of starting and speed control for various applications
- To understand the characteristics of fractional horse power motors.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Analyze the performance of alternator using different testing methods.
- Analyze the characteristics and assess the performance of synchronous motor.
- Analyze the characteristics and select a three phase induction machines for industrial application.
- Apply suitable starting and speed control methods for three phase induction motors.
- Apply the concepts of electric circuit and analyze the performance of fractional horse power motors

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
2	2	2	-	-	-	-	-	-	-	-	-	-	2	1
3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
4	2	2	-	-	-	-	-	-	-	-	-	-	2	-
5	2	3	-	-	-	-	-	-	-	-	-	-	2	2

**UNIT I****10 Hours****ALTERNATOR**

Principle of Operation - Construction - Types of rotor - EMF equation - Armature reaction - Regulation of alternator: EMF, MMF and ZPF method - Capability curve of alternator - Permanent Magnet Synchronous Generator

**UNIT II****8 Hours****SYNCHRONOUS MOTOR**

Principle of operation - Methods of starting - Phasor diagram - V and Inverted V curve - Power angle characteristics - Hunting in synchronous motor - Application of Synchronous motor as synchronous condenser

**UNIT III**

**10 Hours**

**INDUCTION MOTOR**

Concept of Rotating Magnetic Field - Construction - Types of rotor - Operation - torque equation - Torque - slip characteristics - Equivalent circuit model - Induction generator - Linear induction motor.

**UNIT IV**

**8 Hours**

**STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR**

Need for starters - Methods of starting - Fully automated starters: DOL, Autotransformer, star delta starter - rotor resistance starter - Methods of braking, Methods of Speed Control - V/f Control and Pole Changing Techniques

**UNIT V**

**9 Hours**

**FRACTIONAL HORSE POWER MOTOR**

Double Revolving Field Theory - Methods of Starting : Capacitor start - Capacitor start capacitor run - Shaded pole Equivalent circuit model - Universal motor - Stepper motor

**Total: 60 Hours**

**Reference(s)**

1. M.G.Say, Performance and Design of Alternating Current Machines, 3rd Edition, CBS Publisher, 2017
2. D. P. Kothari and I. J. Nagrath, Electric Machines, Tata McGraw Hill Publishing Company Ltd, Fourth Edition 2018
3. Stephen J.Chapman, Electric Machinery Fundamentals, Tata McGraw Hill, New Delhi, 2018
4. E. Fitzgerald, Charles Kingsley, Stephen.D.Umans, Electric Machinery, Tata McGraw Hill publishing Company Ltd, New Delhi ,2015
5. P. S. Bhimbhra, Electrical Machinery, Khanna Publishers, Seventh Edition 2018
6. Acarnley, P. P, Stepping motors: a guide to modern theory and practice, The Institution of Electrical Engineers

**Course Objectives****18EE405 INTEGRATED CIRCUITS AND APPLICATIONS****3 0 0 3**

- To understand the fundamentals and characteristics of Op-amp.
- To understand the linear applications of Op-amp.
- To understand the Non-linear applications of Op-amp.
- To understand the operation of A/D and D/A converters using Op-amp.
- To familiarize the students with the application of Special IC's.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- 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.

m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

n. Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Analyze the DC and AC characteristics of the Op-amp to design simple circuits in opamp.
2. Analyze the performance of Op-Amp based circuits for linear applications.
3. Design and analyze the output of Op-Amps for Wave shaping circuits.
4. Analyze the performance of A/D and D/A converters for electronic applications.
5. Design and analyze various application circuits using Special IC's.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	2	-	-	-	-	-	-	-	-	2	-
2	3	3	1	2	-	-	-	-	-	-	-	-	2	1
3	3	3	2	2	-	-	-	-	-	-	-	-	3	1
4	2	2	2	2	-	-	-	-	-	-	-	-	2	1
5	2	3	3	2	-	-	-	-	-	-	-	-	2	2

**UNIT I****10 Hours****CHARACTERISTICS OF OPERATIONAL AMPLIFIER**

Basic Parameters of Operational Amplifier - Block diagram of Operational Amplifier - Characteristics of Ideal and Practical Operational Amplifier, transfer characteristics - Inverting and Non-inverting Amplifiers, Voltage follower -DC characteristics-AC characteristics-Frequency Response, Stability - Frequency Compensation techniques.

**UNIT II**

**8 Hours**

**LINEAR APPLICATIONS OF OPERATIONAL AMPLIFIER**

Summing amplifier- Differential amplifier - Instrumentation amplifier - Integrator and Differentiator - Voltage to Current and Current to Voltage converters, Oscillators-Sine Wave (RC Phase Shift and Wein Bridge), Triangular Wave and Saw tooth Wave Generation.

**UNIT III**

**10 Hours**

**NON-LINEAR APPLICATIONS OF OPERATIONAL AMPLIFIERS**

Comparators-Zero crossing detector, Schmitt Trigger, Window detector -Clippers, Clampers, Peak Detector-Sample and Hold circuit- Astable and Monostable Multivibrators - Active filters-Analysis and Design of first order low pass, high pass, band pass and Band stop Butterworth filters.

**UNIT IV**

**9 Hours**

**A-D AND D-A CONVERTERS**

DAC/ADC performance characteristics -Digital to Analog Converters: Binary weighted and R-2R Ladder types - Analog to digital converters: Successive approximation and Flash Type. Single Power Supply Operational Amplifiers: Need for single power supply operational amplifiers, AC Inverting and Non-Inverting amplifiers.

**UNIT V**

**8 Hours**

**SPECIAL ICS**

555 Timer circuit -Functional block, Astable and Monostable characteristics, applications; Voltage regulators - fixed voltage regulators, adjustable voltage regulators - switching regulators.

**FOR FURTHER READING**

566-voltage controlled oscillator circuit; 565- PLL Functional Block diagram -Principle of operation, Applications: Frequency synthesis, AM and FM detection, FSK demodulator.

**Total: 45 Hours**

**Reference(s)**

1. David A.Bell, 'Op-amp & Linear ICs', Oxford, 2013.
2. Ramakant A.Gayakward, 'Op-amps and Linear Integrated Circuits', IV edition, Pearson Education, 2015.
3. Jacob Millman, Christos C.Halkias, 'Integrated Electronics - Analog and Digital circuits system',Tata McGraw Hill, 2009.
4. Michael Jacob J, 'Applications and Design with Analog Integrated Circuits', Prentice Hall of India, New Delhi, 2010.
5. Robert F.Coughlin, Fredrick F. Driscoll,Op-amp and Linear ICs, Pearson, 6th edition,2012
6. S. Salivahanan and V.S. Kanchana Bhaaskaran , Linear Integrated Circuits, First reprint, Tata McGraw Hill, 2015.

**18EE406 PYTHON PROGRAMMING****2023****Course Objectives**

- Understand the history and basics of python.
- Gain knowledge about the different data types and control flow statements.
- Impart knowledge about the functions, files, list, set tuples and dictionaries.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- 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.
- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 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.
- 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.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

**Course Outcomes (COs)**

- Construct simple python programs using input output operations.
- Develop python programs using expressions and statements.
- Implement python programs using control flow statements and strings.
- Apply the concepts of functions and files in python programming.
- Design applications using list, sets, tuples and dictionaries in python.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	2	2	2	-	-	1	2	2	-	1	1	-
2	2	2	2	2	2	-	-	1	2	2	-	2	2	-
3	2	3	3	3	3	-	-	1	2	2	-	2	1	-
4	2	3	3	3	3	-	-	1	2	2	2	2	1	-
5	2	3	3	3	3	-	-	1	2	2	2	2	3	-

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

What is Python - History of Python - Features of Python - Simple Program in Python - Commenting in Python - Quotations in Python - Lines and Indentation - Multi-Line Statements - Input Operations - Output Operations.

<b>UNIT II</b>	<b>4 Hours</b>
<b>DATA, EXPRESSIONS, STATEMENTS</b>	
Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.	
<b>UNIT III</b>	<b>8 Hours</b>
<b>CONTROL FLOW STATEMENTS AND STRINGS</b>	
if statement-if-else statement-if-elif-else statement- Nested if - While loop - for loop - else statement used with loops - break statement -continue - pass statement - Strings: string slices -immutability - string functions and methods - In-built string methods - string formatting operations - string module.	
<b>UNIT IV</b>	<b>6 Hours</b>
<b>FUNCTIONS AND FILES</b>	
Functions: return values -parameters - local and global scope - function composition - recursion; Files: Reading and Writing-Format Operators-Filenames and paths.	
<b>UNIT V</b>	<b>6 Hours</b>
<b>LIST, SET, TUPLES AND DICTIONARIES</b>	
Lists as arrays - Lists: list operations - list slices -list methods - list loop - mutability - aliasing - cloning lists - list parameters; Set; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods.	
<b>1</b>	<b>2 Hours</b>
<b>EXPERIMENT 1</b>	
Program to implement basic operators.	
<b>2</b>	<b>2 Hours</b>
<b>EXPERIMENT 2</b>	
Program for Operator Precedence.	
<b>3</b>	<b>2 Hours</b>
<b>EXPERIMENT 3</b>	
Program to implement the concept of function.	
<b>4</b>	<b>3 Hours</b>
<b>EXPERIMENT 4</b>	
Develop the program for selection statements.	
<b>5</b>	<b>3 Hours</b>
<b>EXPERIMENT 5</b>	
Program to implement looping statements.	
<b>6</b>	<b>3 Hours</b>
<b>EXPERIMENT 6</b>	
Program to implement break and continue statements.	
<b>7</b>	<b>3 Hours</b>
<b>EXPERIMENT 7</b>	
Develop a program to implement the concept of Recursion.	
<b>8</b>	<b>3 Hours</b>
<b>EXPERIMENT 8</b>	
Program to implement string functions.	
<b>9</b>	<b>3 Hours</b>
<b>EXPERIMENT 9</b>	
Implement the concept of list.	

**10**

**3 Hours**

**EXPERIMENT 10**

Develop a program to implement tuples.

**11**

**3 Hours**

**EXPERIMENT 11**

Program to implement set, dictionaries.

**Total: 60 Hours**

**Reference(s)**

1. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2nd edition, Updated for Python 3, Shroff Reilly Publishers, 2016 (<http://greenteapress.com/wp/think-python/>)
2. Guido van Rossum and Fred L. Drake Jr, An Introduction to Python -Revised and updated for Python 3.2, Network Theory Ltd., 2014.
3. Charles Dierbach, Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2015.
4. John V Guttag, Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press , 2017.

**18EE407 ELECTRICAL MACHINES II****LABORATORY****0021****Course Objectives**

- To understand the performance of a three phase induction motor by direct loading method.
- To understand the performance characteristics of an induction generator with self-excitation.
- To analyze the performance parameters of special motors by conducting suitable test.

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- d. 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.
- i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- j. 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.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Analyze the load characteristics of three phase induction motor and evaluate its performance.
2. Apply speed control techniques for three phase induction motor.
3. Apply the braking techniques to regulate the speed of three phase induction motor.
4. Evaluate the performance characteristics of self-excited induction generator and axial flux generator.
5. Analyze the load characteristics of BLDC motor and its performance.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	-	1	-	-	-	-	2	2	-	-	3	1
2	2	3	-	2	-	-	-	-	2	2	-	-	3	1
3	2	3	-	3	-	-	-	-	2	2	-	-	3	1
4	3	2	-	3	-	-	-	-	2	2	-	-	2	1
5	2	3	-	1	-	-	-	-	2	2	-	-	2	1

<b>1</b>	<b>3 Hours</b>
<b>EXPERIMENT 1</b> Performance curves of three phase squirrel cage induction motor by direct loading method.	
<b>2</b>	<b>3 Hours</b>
<b>EXPERIMENT 2</b> Separation of no load losses in three phase squirrel cage induction motor.	
<b>3</b>	<b>3 Hours</b>
<b>EXPERIMENT 3</b> Speed control of three phase induction motor.	
<b>4</b>	<b>4 Hours</b>
<b>EXPERIMENT 4</b> Equivalent circuit and circle diagram for three phase induction motor	
<b>5</b>	<b>3 Hours</b>
<b>EXPERIMENT 5</b> Braking methods of three phase induction motor.	
<b>6</b>	<b>4 Hours</b>
<b>EXPERIMENT 6</b> Load test on self-excited induction generator.	
<b>7</b>	<b>4 Hours</b>
<b>EXPERIMENT 7</b> Performance analysis of three phase AC motor coupled Axial Flux Generator.	
<b>8</b>	<b>3 Hours</b>
<b>EXPERIMENT 8</b> Speed control of BLDC Motor.	
<b>9</b>	<b>3 Hours</b>
<b>EXPERIMENT 9</b> Load characteristics of BLDC motor.	

**Total: 30 Hours**

**Reference(s)**

1. E. Fitzgerald, Charles Kingsley, Jr. Stephen D. Umans, Electric Machinery, Sixth Edition, Tata McGraw Hill Publishing Company Ltd., 2002.
2. M.G.Say, Performance and Design of Alternating Current Machines, 3rd Edition, CBS Publisher
3. D. P. Kothari and I. J. Nagrath, Electric Machines, Tata McGraw Hill Publishing Company Ltd, Fourth Edition 2010
4. Raj put R.K, Electric Machines, Lakshmi publication, fifth edition, reprinted at 2011
5. P. S. Bhimbhra, Electrical Machinery, Khanna Publishers, Seventh Edition 2011
6. Miller T.J.E. Brushless permanent Magnet and Reluctance Motor Drives, Clarendon Press

**18EE408 DIGITAL AND INTEGRATED CIRCUITS  
LABORATORY**

0 0 2 1

**Course Objectives**

- To analyze the operation of combinational and Sequential digital circuits.
- To apply the principles of Op-amp in linear and non linear applications.
- To understand the applications of 555 timer IC.

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- d. 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.
- e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- j. 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.
- l. 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.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Design and implementation of combinational and sequential logic circuits using logic gates.
2. Design and Implementation of digital circuits using VHDL.
3. Design wave shaping circuits, ADC and DAC using op amp.
4. Design and Implementation of real time applications using Op-Amp.
5. Design and construct astable and monostable multivibrators using IC555 timer.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	3	1	3	-	-	-	2	2	-	1	2	2
2	2	2	3	-	3	-	-	-	2	2	-	1	2	2
3	2	2	3	1	-	-	-	-	2	2	-	1	2	2
4	3	2	3	-	-	-	-	-	2	2	-	1	2	2
5	2	2	3	1	-	-	-	-	2	2	-	1	2	2

<b>1</b>		<b>4 Hours</b>
<b>EXPERIMENT 1</b>		
	Simulation of logic gates and design Full adder and Full subtractor circuits by using VHDL.	
<b>2</b>		<b>2 Hours</b>
<b>EXPERIMENT 2</b>		
	Experimental verification of logic gates and design adder, subtractor and three variable Boolean Functions.	<b>4 Hours</b>
<b>EXPERIMENT 3</b>		
	Design and implementation of Multiplexer and Demultiplexer using logic gates	
<b>3</b>		<b>4 Hours</b>
<b>EXPERIMENT 4</b>		
	Verification of RS and JK Flip-flop and design the bidirectional shift registers by VHDL.	
<b>4</b>		<b>2 Hours</b>
<b>EXPERIMENT 5</b>		
	Design and implementation of counters by behavioural modeling of VHDL	
<b>5</b>		<b>4 Hours</b>
<b>EXPERIMENT 6</b>		
	Design and implementation of differentiator and integrator circuits by using op-amp.	
<b>6</b>		<b>2 Hours</b>
<b>EXPERIMENT 7</b>		
	Design and implementation of Instrumentation amplifier by using op-amp	
<b>7</b>		<b>2 Hours</b>
<b>EXPERIMENT 8</b>		
	Design and implementation of simple Microphone to Speaker circuit by using op-amp	
<b>8</b>		<b>2 Hours</b>
<b>EXPERIMENT 9</b>		
	Design and implementation of analog to digital converter and digital to analog converter using op-amp.	
<b>9</b>		<b>4 Hours</b>
<b>EXPERIMENT 10</b>		
	Design and implementation of Astable and Monostable Multivibrators using IC 555 Timer.	

**Total: 30 Hours**

**18HS001 ENVIRONMENTAL SCIENCE****2 0 0 0****Course Objectives**

- Understand the interdisciplinary and holistic nature of the environment
- Identify the significance of natural resources and environment on the quality of life and stimulate the quest for sustainable development
- Assess the socio-economic, political and ethical issues in environmental science

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

**Course Outcomes (COs)**

- Apply the knowledge of forest, water, food, mineral and energy resources for sustainable exploitation of natural resources
- Analyze the four types of ecosystems and biodiversity, its values and role of professionals in protecting the environment from degradation
- Identify the existing environmental challenges related to air, water, soil, noise, thermal pollution and its management plan
- Analyze the strategies of solid waste management, water management and climate change mitigation as a goal towards sustainable development
- Analyze the impact of population growth and value education on the development of a country

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	-	-	-	-	-	-	-	-	-	-	2	-
2	1	1	-	-	-	-	-	-	-	-	-	-	3	-
3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
4	1	-	-	-	-	-	1	-	-	-	-	-	1	-
5	2	-	-	-	-	-	1	-	-	-	-	-	2	-

**UNIT I****6 Hours****NATURAL RESOURCES**

Forest resources: Use - over exploitation - deforestation - case studies. Water resources: Use - over utilization of surface and ground water - conflicts over water. Mineral resources: Use – exploitation environmental effects of extracting and using mineral resources - case studies. Food resources: Effects of modern agriculture - fertilizer-pesticide problems (eutrophication, blue baby syndrome, biomagnification) - water logging - salinity - case studies. Energy resources: renewable(solar, wind, tidal, geothermal and hydroelectric power) - non renewable energy sources

**UNIT II**

**6 Hours**

**ECOSYSTEMS AND BIODIVERSITY**

Concept of an ecosystem: Structure and function of an ecosystem - producers - consumers - decomposers - food chains - food webs and ecological pyramids - Types of ecosystem: Introduction - characteristic features: forest ecosystem - desert ecosystem - ecological succession. Biodiversity - value of biodiversity - threats to biodiversity - endangered and endemic species - Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity - field study

**UNIT III**

**6 Hours**

**ENVIRONMENTAL POLLUTION**

Pollution: Definition - causes - effects - control measures of air pollution - water pollution : (Sewage water treatment by activated sludge and trickling filter process) - marine pollution - thermal pollution - noise pollution. Disaster management: causes - effects - control measures of floods - earthquake - cyclone – landslides

**UNIT IV**

**7 Hours**

**SOCIAL ISSUES AND ENVIRONMENT**

Sustainable development : Definition - Unsustainable to sustainable development - urban problems related to energy. Environmental ethics - issues and possible solutions - solid waste management - causes - effects - 3R Principles (landfills, incineration, composting). Water conservation - rain water harvesting - watershed management. Climate change - global warming - acid rain - ozone layer depletion. Environment protection act: Air (Prevention and control of pollution) act - wildlife protection act.

**UNIT V**

**5 Hours**

**HUMAN POPULATION AND ENVIRONMENT**

Human population: Population growth - characteristics - variation among nations - population explosion - women and child welfare programmes - value education - HIV / AIDS. Role of information technology in environment and human health - occupational safety and health administration (OSHA)

**FOR FURTHER READING**

Human rights: E - waste and biomedical waste -Identification of adulterants in food materials

**Total: 30 Hours**

**Reference(s)**

1. Anubha Kaushik, C.P. Kaushik, Environmental Science and Engineering , 4th Multi Colour Edition, New Age International Publishers, New Delhi, 2014
2. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons
3. T. G. Jr. Miller, S. Spoolman, New Environmental Science, 14th Edition, Wadsworth Publishing Co, New Delhi, 2014
4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press
5. A. K. De, Environmental Chemistry, 7th Edition , New age international publishers, New Delhi, 2014

**21EE501 POWER SYSTEM ANALYSIS****3 1 0 4****Course Objectives**

- To apply the concept of per unit systems in power system computations.
- To develop algorithms for power system planning.
- To understand the application of power system matrices.
- To understand the concept of symmetrical components.
- To analyze the stability of given network.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- 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.
- Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

**Course Outcomes (COs)**

- Apply the concept of per unit systems to construct the reactance diagram and develop the network matrices of the power system network.
- Evaluate the power flow and losses in a power system network using non-linear iterative solution methods for power system planning.
- Apply the concepts of bus impedance matrix and reactance diagrams to predict the effects of balanced faults in power system.
- Analyse the effects of unbalanced faults in power systems using the concept of symmetrical components for power system protection.
- Evaluate the stability of the power system during transient operations.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	-	-	-	-	-	-	-	-	2	-	3	-
2	3	3	-	2	-	-	1	-	-	-	-	-	3	-
3	3	3	-	2	-	1	-	-	-	-	2	-	3	-
4	3	3	-	2	-	1	-	-	-	-	2	-	3	-
5	3	3	-	2	-	-	1	-	-	-	-	-	3	-

**UNIT I****9 Hours****POWER SYSTEM MODELING**

Single line diagrams -Per unit system -Per unit impedance/ reactance diagrams -Formation of network matrices - Y bus formation using inspection and singular transformation -Z bus formation using step-by- step building algorithm method.

**UNIT II** **8 Hours**

**LOAD FLOW ANALYSIS**

Load flow equations and methods of solution -Slack bus concept -Gauss Seidal, Newton Raphson, Fast decoupled methods for load flow studies.

**UNIT III** **8 Hours**

**FAULT ANALYSIS - SYMMETRICAL FAULTS**

Importance of short circuit analysis - assumptions in fault analysis - analysis using Thevenin's theorem - Z-bus building algorithm - fault analysis using Z-bus - computations of short circuit capacity, post fault voltage and currents.

**UNIT IV** **11 Hours**

**FAULT ANALYSIS - UNSYMMETRICAL FAULTS**

Introduction to symmetrical components - sequence impedances - sequence circuits of synchronous machine, transformer and transmission lines - sequence networks analysis of single line to ground, line to line and double line to ground faults using Thevenin's theorem and Z-bus matrix.

**UNIT V** **9 Hours**

**POWER SYSTEM STABILITY**

Steady state and transient stability -Swing equation and its solution method (step by step) -Equal area criterion -Factors affecting stability and methods of improving stability.

**FOR FURTHER READING**

Overview of Indian power scenario- Electricity Deregulation-Captive Power Plants

**Total: 60 Hours**

**Reference(s)**

1. I.J. Nagarath, D.P. Kothari, Modern Power System Analysis, Tata McGraw Hill Publishing Company, New Delhi, 2013.
2. John Grainger, William Stevenson JR, Power System Analysis, Mcgraw-Hill Series in Electrical and Computer Engineering, New Delhi, 2014.
3. Hadi Saadat, Power System Analysis, PSA Publishers, New Delhi, 2013.
4. P.Kundur, Power System Stability and Control, Tata McGraw Hill Book Company, New Delhi, 2013.
5. Charles A. Gross, Power System Analysis, Wiley India Pvt Ltd, Second edition, 2010.
6. P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan, Electrical Power Systems Analysis, Security and Deregulation, PHI Learning Private Limited, New Delhi, 2012.

**21EE502 CONTROL SYSTEMS****3 1 0 4****Course Objectives**

- To understand the basic concepts of open loop and closed loop control systems.
- To analyze the given system in time domain.
- To understand the concept of frequency domain analysis
- To understand the concept of stability of system
- To design the compensator for different control systems

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Develop a mathematical model of a physical system and compute the transfer function using Block diagram reduction technique and Signal flow graph.
- Analyze the performance of first and second order system and compute the steady state error using different test signals.
- Analyze the frequency response of a given system and comment the stability.
- Analyze the stability of a given system using Routh Hurwitz criterion, Nyquist stability criterion and Root Locus techniques.
- Apply the concept of lag, lead and lag lead compensator for open loop system and examine a system using state variable techniques

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	-	-	-	-	-	-	-	-	-	3	-
2	3	3	-	-	-	-	-	-	-	-	-	-	3	-
3	3	3	-	2	-	-	-	-	-	-	-	-	3	-
4	3	3	-	2	-	-	-	-	-	-	-	-	3	-
5	3	3	1	2	-	-	-	-	-	-	-	-	3	3

**UNIT I****10 Hours****MATHEMATICAL MODEL OF PHYSICAL SYSTEMS**

Introduction- Basic Elements of control systems-Open loop and closed loop system - Elements of Control system - Transfer function of mechanical translational and rotational system, electrical system - Electrical analogy of mechanical system - Block diagram reduction technique - Signal flow graph.

**UNIT II** **8 Hours**

**TIME DOMAIN ANALYSIS**

Standard test signals - Time response of first order and second order systems for unit step test signals - Time domain specifications-Steady state response - Static error constants - steady state error - Effects of proportional derivative, proportional integral systems.

**UNIT III** **9 Hours**

**FREQUENCY DOMAIN ANALYSIS**

Frequency response of systems - Frequency domain specifications - Correlation between frequency domain and time domain specifications - Bode plot, Polar plot

**UNIT IV** **10 Hours**

**STABILITY ANALYSIS OF CONTROL SYSTEM**

Concepts of stability - Necessary conditions for Stability-Characteristics equation - Location of roots in S plane for stability - Routh Hurwitz criterion-Nyquist stability criterion- Root Locus technique- Relative Stability

**UNIT V** **8 Hours**

**COMPENSATOR DESIGN**

Compensators, Design of Lag compensator - Lead compensator - Lag-lead compensator (using Bode plot) - Concept of state, state variable, state model, Controllability and observability

**Total: 60 Hours**

**Reference(s)**

1. I.J.Nagrath and M.Gopal, Control System Engineering, NewAge International Publisher,2018
2. M.Gopal, Control System Principles and Design,TataMcGraw-Hill,2012.
3. K.Ogatta, Modern Control Engineering, Pearson Education, NewDelhi, 2015
4. BenjaminC. Kuo, Automatic Control Systems, Prentice-Hall of India Pvt. Ltd.2014
5. M.N.Bandyopadhyay, Control Engineering Theory and Practice, Prentice Hall of India,2009

**21EE503 MEASUREMENT AND INSTRUMENTATION****3 0 2 4****Course Objectives**

- To understand the fundamental concepts of measuring instruments.
- To understand the operation of various analog instruments.
- To understand the operation of various digital instruments.
- To measure R, L and C elements using DC and AC bridges.
- To learn the principle and working of various transducers.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Examine the various types of errors in measurement and utilize statistical evaluation techniques to minimize their impact on measurement data.
- Apply the concept of Faradays Law in various types of Analog Instruments and predict the types of errors associated with them.
- Analyze voltage, phase, and power quality in electrical systems using digital measurement techniques
- Design a suitable bridge for the measurement of unknown resistance, Inductance and Capacitance.
- Assess the operating characteristics of different transducers for real time applications.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	-	-	-	-	-	-	-	2	2	-	-	2	-
2	2	1	-	-	-	-	-	-	2	2	-	-	2	2
3	2	2	-	-	-	-	-	-	2	2	-	-	2	2
4	3	3	2	-	-	-	-	-	2	2	-	-	3	-
5	2	1	-	-	-	-	-	-	2	2	-	-	3	-

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

Units and dimensions, Functional elements of an instruments, Static and dynamic characteristics, Errors in measurement, Statistical evaluation of measurement data, Standards and calibration.

<b>UNIT II</b>	<b>9 Hours</b>
<b>ANALOG INSTRUMENTS</b>	
Moving coil instruments: Permanent magnet moving coil instruments, Moving iron: attraction and repulsion type instruments- Torque equations and errors, Single and Three phase watt meters and Energy meters.	
<b>UNIT III</b>	<b>10 Hours</b>
<b>DIGITAL INSTRUMENTS</b>	
Introduction, Digital Multi-meter: Block diagram, principle of operation, Digital Voltmeter: Block diagram, principle of operation, Types-Integrating type voltmeter, Digital Phase meter, Power quality analyzer.	
<b>UNIT IV</b>	<b>9 Hours</b>
<b>MEASUREMENT OF ELECTRICAL AND NON ELECTRICAL QUANTITIES</b>	
Measurement of Resistance:Kelvin double bridge,Wheatstone bridge, Measurement of inductance and capacitance: Maxwell and Schering bridge,Earth Resistance Tester, Measurement of Temperature: Thermocouples, Radiation and Optical pyrometer.	
<b>UNIT V</b>	<b>8 Hours</b>
<b>TRANSDUCERS</b>	
Selection of transducer, Classification of transducers: Resistive ,capacitive & inductive transducers, Piezoelectric, Hall Effect Transducers.	
<b>FOR FURTHER READING</b>	
Calibration of Meters, Smart sensors.	
<b>1</b>	<b>2 Hours</b>
<b>EXPERIMENT 1</b>	
Displacement measurement using LVDT.	
<b>2</b>	<b>4 Hours</b>
<b>EXPERIMENT 2</b>	
Experimental verification of Wheatstone bridge.	
<b>3</b>	<b>4 Hours</b>
<b>EXPERIMENT 3</b>	
Experimental verification of Kelvin double bridge.	
<b>4</b>	<b>4 Hours</b>
<b>EXPERIMENT 4</b>	
Experimental verification of Maxwells inductance bridge.	
<b>5</b>	<b>4 Hours</b>
<b>EXPERIMENT 5</b>	
Experimental verification of Schering bridge	
<b>6</b>	<b>2 Hours</b>
<b>EXPERIMENT 6</b>	
Calibration of ammeter and voltmeter.	

<b>7</b>	<b>2 Hours</b>
<b>EXPERIMENT 7</b> Calibration of Wattmeter.	
<b>8</b>	<b>2 Hours</b>
<b>EXPERIMENT 8</b> Calibration of single phase energy meter.	
<b>9</b>	<b>4 Hours</b>
<b>EXPERIMENT 9</b> Temperature measurement using RTD, Thermistor and IC AD590.	
<b>10</b>	<b>2 Hours</b>
<b>EXPERIMENT 10</b> Measurements using cathode ray oscilloscope.	

**Total: 75 Hours**

**Reference(s)**

1. A. K. Sawhney, A Course in Electrical & Electronic Measurements & Instrumentation, 19th edition Dhanpat Rai and Co, 2014.
2. E. O. Doebelin, Measurement Systems Application and Design, Tata McGraw Hill Publishing Company, 2007.
3. D. V. S. Murthy, Transducers and Instrumentation, Prentice Hall of India Pvt Ltd, 2004.
4. H. S. Kalsi, Electronic Instrumentation, Tata McGraw Hill, 3rd edition 2012.
5. J. B. Gupta, A Course in Electronic and Electrical Measurements, S. K. Kataria & Sons, Delhi, 2008.

**21EE504 POWER ELECTRONICS****3 1 0 4****Course Objectives**

- To analyze the static and switching characteristics of power semi-conductor devices.
- To understand the operation of controlled rectifiers.
- To understand and analyze the various types of choppers.
- To evaluate the operation, characteristics and performance parameters of Inverters.
- To understand the operation of ac-ac converters.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Analyze the static and dynamic characteristics of power semiconductor devices for reliable application in power electronics systems.
- Analyze the input and output parameters of controlled rectifiers with R, RL and RLE Load for power control applications.
- Apply the various converter topologies to design and analyze the switched mode regulators.
- Analyze the operation of inverter topologies with different PWM schemes for efficient power conversion.
- Analyze the performance parameters of AC- AC converters to evaluate their effectiveness in AC- AC power conversion applications.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	-	-	-	-	-	-	-	-	1	1	1
2	3	2	1	-	-	-	-	-	-	-	-	1	3	2
3	3	2	2	-	-	-	-	-	-	-	-	1	3	2
4	2	2	2	-	-	-	-	-	-	-	-	1	3	2
5	2	1	1	-	-	-	-	-	-	-	-	1	3	2

**UNIT I****9 Hours****POWER SEMI-CONDUCTOR DEVICES**

Construction Operation Static and Dynamics characteristics of Power Diode-Power BJT -SCR -DIAC - TRIAC- GTO -MOSFET - IGBT Ratings of Devices Protection of Devices.

**UNIT II**

**10 Hours**

**CONTROLLED RECTIFIERS**

Single Phase and Three Phase Half and Fully controlled rectifier with R, RL, RLE Load - Effect of Freewheeling Diode -Continuous and Discontinuous Mode of operation - Performance Analysis - Dual converter.

**UNIT III**

**8 Hours**

**CHOPPERS**

Classification -control strategies - Buck, Boost, and Buck-Boost - Performance analysis - PWM techniques for choppers- Switched mode regulators

**UNIT IV**

**12 Hours**

**INVERTERS**

Single Phase H - Bridge and Cascaded H Bridge - Three Phase Voltage Source Inverters - Single phase and Three Phase Current Source Inverters - Performance analysis - PWM techniques. - Analysis of Harmonic Distortion.

**UNIT V**

**6 Hours**

**AC-AC CONVERTERS**

Performance analysis of Single Phase and Three Phase AC Voltage Controllers - Single phase Matrix converters.

**Total: 60 Hours**

**Reference(s)**

1. Muhammad H.Rashid, Power Electronics Circuits, Devices & Applications 4th Edition, Pearson India, 2017.
2. NedMohan, Tore.M.Undeland, William.P.Robbins, Power Electronics: Converters, Applications and Design,3rd Edition WileyIndia, NewDelhi, 2007.
3. M.D.Singh & K.B Khanchandani. Power Electronics 2nd Edition Tata Mc Graw Hill Publishing Co.Ltd., New Delhi,2008.
4. D. Ronanki, S. Singh, S. Williamson, "Comprehensive Topological Overview of Rolling Stock Architectures and Recent Trends in Electric Railway Traction Systems", IEEE Trans. Transportation Electrification., vol. 3, no. 3, pp. 724-738, May 2017.
5. E. Babaei, S. Alilu, and S. Laali, "A new general topology for cascaded multilevel inverters with reduced number of components based on devel-oped H-bridge,-IEEE Trans. Ind. Electron., vol. 61, no. 8, pp. 3932-3939,Aug. 2014

**21EE507 POWER SYSTEM SIMULATION LABORATORY****0 0 2 1****Course Objectives**

- To acquire programming skills and experience in the usage of standard packages like Matlab and E-Tap necessary for power system analysis
- To acquire knowledge required for planning, operation and control of power system networks through simulation

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering 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.
- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

**Course Outcomes (COs)**

- Apply the concepts of graph theory to determine the network incidence matrices.
- Evaluate the power flow and losses in a power system network using non-linear iterative solution methods.
- Analyse the short circuit current in a power system network following a fault, using simulation tools.
- Develop a program to determine the economic loading point of synchronized generating units
- Analyse rotor angle stability in a power system network using simulation tools.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	-	-	2	3	-	-	2	2	2	-	-	3	-
2	2	-	-	2	3	-	-	2	2	2	-	-	3	-
3	2	-	-	2	3	-	-	2	2	2	-	-	3	-
4	2	-	-	2	3	-	-	2	2	2	-	-	3	-
5	2	-	-	2	3	-	-	2	2	2	-	-	3	-

**1****4 Hours****EXPERIMENT 1**

Formation of Bus Admittance Matrix and Bus Impedance Matrix

**2****4 Hours****EXPERIMENT 2**

Formation of Bus incidence matrix and loop incidence matrix.

<b>3</b>		<b>4 Hours</b>
<b>EXPERIMENT 3</b>		
Formation of Branch path incidence matrix and Basic cutest matrix.		
<b>4</b>		<b>2 Hours</b>
<b>EXPERIMENT 4</b>		
Solution of Power Flow and Related Problems Using Gauss-Seidel method		
<b>5</b>		<b>4 Hours</b>
<b>EXPERIMENT 5</b>		
Solution of Power Flow and Related Problems Using Newton-Raphson Method		
<b>6</b>		<b>4 Hours</b>
<b>EXPERIMENT 6</b>		
Solution of Power Flow and Related Problems Using Fast-Decoupled Load Flow		
<b>7</b>		<b>2 Hours</b>
<b>EXPERIMENT 7</b>		
Short Circuit analysis		
<b>8</b>		<b>2 Hours</b>
<b>EXPERIMENT 8</b>		
Economic Dispatch in Power Systems		
<b>9</b>		<b>2 Hours</b>
<b>EXPERIMENT 9</b>		
Transient Stability Analysis		
<b>10</b>		<b>2 Hours</b>
<b>EXPERIMENT 10</b>		
Contingency Analysis		
		<b>Total: 30 Hours</b>

**21EE508 CONTROL SYSTEMS LABORATORY****0 0 2 1****Course Objectives**

- To understand the basic concepts of open loop and closed loop control systems
- To analyze the given system in time domain
- To understand the concept of frequency domain analysis
- To understand the concept of stability of system

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- 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.
- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- 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.
- Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
- 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.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Construct the transfer function of AC servo motor and analyze the performance of the system.
- Analyze the time and frequency domain response of linear and nonlinear systems.
- Apply the bode plot and root-locus technique to analyze the stability of the control system.
- Analyze the performance of induction motor and PMDC motor with closed loop control system.
- Design and verify the performance of different types of controllers for given applications.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	-	-	2	-	-	2	2	-	1	3	2
2	3	3	-	2	-	-	-	-	2	2	-	-	2	-
3	3	-	3	-	-	-	-	-	2	2	-	-	3	-
4	3	3	-	2	1	-	-	-	2	2	-	-	3	2
5	1	-	3	-	2	-	-	-	2	2	-	-	3	1

<b>1</b>		<b>4 Hours</b>
	<b>EXPERIMENT 1</b>	
	Determine the transfer function of AC servo motor.	
<b>2</b>		<b>2 Hours</b>
	<b>EXPERIMENT 2</b>	
	Design a servo mechanism for robotic arm control using PIC.	
<b>3</b>		<b>4 Hours</b>
	<b>EXPERIMENT 3</b>	
	Analyze the response of given first order system with step, ramp and impulse inputs	
<b>4</b>		<b>4 Hours</b>
	<b>EXPERIMENT 4</b>	
	Develop a state model for given system and analyze its stability using Bode plot and Root locus	
<b>5</b>		<b>4 Hours</b>
	<b>EXPERIMENT 5</b>	
	Realization of first order and second order system using op-amp.	
<b>6</b>		<b>2 Hours</b>
	<b>EXPERIMENT 6</b>	
	Design and analysis of lag and lead compensator.	
<b>7</b>		<b>2 Hours</b>
	<b>EXPERIMENT 7</b>	
	Design and verify the performance of P, PI and PID controllers	
<b>8</b>		<b>4 Hours</b>
	<b>EXPERIMENT 8</b>	
	Experimental verification of closed loop control system for 3 phase induction motor	
<b>9</b>		<b>2 Hours</b>
	<b>EXPERIMENT 9</b>	
	Design and implementation of closed loop control system for PMDC motor.	
<b>10</b>		<b>2 Hours</b>
	<b>EXPERIMENT 10</b>	
	Study and experimental verification of Programmable Logic Controller for given applications	
		<b>Total: 30 Hours</b>

**Reference(s)**

1. I.J.Nagrath and M.Gopal, Control System Engineering, NewAge International Publisher,2018
2. K.Ogatta, Modern Control Engineering, Pearson Education, NewDelhi, 2015
3. M.Gopal, "Control System Principles and Design",TataMcGraw-Hill,2012
4. S.Palani, Control System Engg, TataMcGraw-Hill, 2016

**21EE601 POWER SYSTEM PROTECTION AND****SWITCH GEAR****3 1 0 4****Course Objectives**

- To understand the different types of protection schemes in power system
- To understand the construction and operating principle of protective relays
- To gain knowledge on transmission line and apparatus protection schemes
- To understand the concept of arc phenomena, arc interruption and lightning arresters
- To illustrate the construction and operating principle of circuit breakers

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Analyze the different types of faults and protection schemes in power systems.
- Evaluate the characteristics of protective relays and recommend suitable relay schemes for power system protection.
- Select and apply appropriate protection schemes for alternators, transformers, motors, bus bars, and feeders.
- Apply the arc interruption schemes in Circuit Breakers.
- Analyze the performance of different types of circuit breakers in electrical systems.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	-	-	-	2	2	-	-	-	-	1	-	3
2	3	2	-	-	-	2	2	-	-	-	-	-	-	3
3	3	2	-	-	-	2	2	-	-	-	-	-	-	3
4	3	2	-	-	-	2	2	-	-	-	-	-	-	3
5	3	2	-	-	-	3	2	-	-	-	-	2	-	3

**UNIT I****8 Hours****INTRODUCTION TO PROTECTION SCHEMES**

Principles and need for protective schemes, Nature and causes of faults, primary and backup protection, Electromagnetic relays, Comparison between static and electromagnetic relays, Step and Touch potential, Zones of protection, Power System Earthing.

**UNIT II**

**10 Hours**

**PROTECTIVE RELAY**

Non directional and directional over current relays, Static and numerical over current relays, Distance relay - Impedance, reactance and mho relays, Differential and pilot relaying schemes, Auto reclosing and synchronizing.

**UNIT III**

**9 Hours**

**APPARATUS AND LINE PROTECTION**

Alternator, transformer, induction motor, bus bar and feeder protection schemes, CTs and PTs and their applications in protection schemes, microprocessor based protective schemes

**UNIT IV**

**8 Hours**

**THEORY OF CIRCUIT INTERRUPTION**

Physics of arc phenomena and arc interruption, Restriking voltage, Recovery voltage, rate of rise of restriking voltage, resistance switching, current chopping and interruption of capacitive current, lightning arresters and its types.

**UNIT V**

**CIRCUIT BREAKERS**

**10 Hours**

Introduction- Rating of Circuit Breakers, Types of Circuit Breakers-Miniature, Earth leakage, Air blast, Air break, oil, SF6 and Vacuum circuit breakers with advantages and disadvantages, High voltage dc circuit breakers- Maintenance and Testing of circuit breakers-Recent developments in protective relays.

**Total: 60 Hours**

**Reference(s)**

1. Badri Ram, D.N.Viswakarma "Power system Protection and switchgear", Tata Mcgraw Hill, Private Limited, New Delhi, 2013.
2. Bhaveshbhalja, R.P. Maheshwari, Nilesh G. Chothani, "Protection and Swtichgear", Oxford University press, 2014.
3. Sunil S. Rao, "Switchgear Protection and Power Systems", Khanna publishers, New Delhi, 13th Edition, Reprint 2008.
4. V.K.Metha and Rohit Metha "Principles of power system", S. Chand company Ltd, 2011.
5. Wadhwa C L, "Electrical Power Systems", New age International (P) Ltd., Sixth Edition, 2010.
6. Bo, Z.Q., Lin, X.N., Wang, Q.P. et al. Developments of power system protection and control(2016)

**21EE602 MICROCONTROLLERS BASED SYSTEM DESIGN****3 0 0 3****Course Objectives**

- To understand RISC and CISC architecture, pipelining and evaluation.
- To understand the architectural features of the hardware and interfacing peripheral devices to PIC 16Fxx
- To acquire sound knowledge of PIC Microcontroller
- To gain knowledge of LPC2148 architecture.
- To understand the concepts of MSP430 Architecture

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
- 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.
- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Apply the architectural features of PIC microcontrollers to implement basic embedded functions for user-interactive applications.
- Apply interrupt handling techniques in PIC microcontrollers to implement task switching and real-time response in embedded applications.
- Analyze the operation of peripheral and interfacing features for data handling and system functionality.
- Analyze the ARM architecture, instruction sets, and organization for automation.
- Design embedded solutions using MSP430 by integrating its functional blocks and Code Composer Studio tools for specific application requirements.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	2	-	2	-	-	-	-	-	2	-	3	1
2	2	1	2	-	2	-	-	-	-	-	2	-	3	-
3	2	1	2	-	2	-	-	-	-	-	2	-	3	-
4	2	1	2	-	2	-	-	-	-	-	2	-	3	1
5	2	1	2	-	2	-	-	-	-	-	2	-	3	1

**UNIT I**

**9 Hours**

**INTRODUCTION TO PIC MICROCONTROLLER**

Introduction to PIC microcontrollers, PIC 16FXX architecture, comparison of PIC with other CISC and RISC based systems - Pipelining - Program Memory considerations - Register File Structure - Addressing modes - Simple Operations.

**UNIT II**

**9 Hours**

**INTERRUPTS AND TIMER**

PIC micro controller Interrupts- External Interrupts-Interrupt Programming - Loop time subroutine - Timers-Timer Programming - Front panel I/O-Soft Keys - key switches- Display of Constant and Variable strings.

**UNIT III**

**9 Hours**

**PERIPHERALS AND INTERFACING**

I2C Bus for Peripherals Chip Access - Bus operation-Bus subroutines - Serial EEPROM - analog to Digital Converter - UART-Baud rate selection - Data handling circuit - Initialization - LCD and keyboard Interfacing -ADC, DAC, and Sensor Interfacing.

**UNIT IV**

**9 Hours**

**INTRODUCTION TO ARM**

The ARM architecture -ARM assembly language program -ARM organization and implementation – The ARM instruction set-The thumb instruction set -ARM CPU cores - GPIO Programming, Timer Programming, Interrupt programming, Serial Port Programming, LCD and Keyboard interfacing

**UNIT V**

**9 Hours**

**INTRODUCTION TO MSP430**

MSP430 Architecture: Introduction - Functional block diagram - Memory - Central Processing Unit - Memory Mapped Input and Output - - Instruction Set - Introduction to Code Composer Studio (CCS v4).Understanding how to use CCS for MSP430 microcontrollers-Interrupt programming-Digital I/O-I/O ports programming using C.

**Total: 45 Hours**

**Reference(s)**

1. Peatman,J.B., Design with PIC Micro Controllers PearsonEducation,3rdEdition, 2004.
2. Mazidi, M.A., Rollin Mckinlay, Danny causey PIC Microcontroller, Prentice Hall of India, 2007
3. Myke Predko , Programming and Customizing the PIC Microcontroller TAB electronics,Third Edition, 2009
4. Furber,S., ARM System on Chip Architecture, Addison Wesley trade Computer Publication, 2009.
5. Technical documents related to MSP-EXP430G2 and Tiva C Series TM4C123G

**21EE603 DIGITAL SIGNAL PROCESSING****3 1 0 4****Course Objectives**

- To understand the signals and systems and their mathematical representation in time/frequency domain
- To analyze the discrete time systems using Z-transform and Inverse Z-transform
- To implement the discrete time systems in Discrete Fourier Transform using Fast Fourier Transform algorithm
- To design FIR, IIR filters with its response and obtaining its realization structure
- To understand the architectural overview and addressing modes in DSP processors

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- 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.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Analyze mathematical functions, classify signals and systems, and apply sampling and quantization concepts for analog-to-digital conversion.
- Analyze the stability of discrete-time systems using the Z-transform and apply the discrete time Fourier transform for time domain to frequency domain conversion.
- Apply the discrete Fourier transform and fast Fourier transform for the discrete-time systems for time domain to frequency domain conversion.
- Design FIR and IIR filters, analyze their responses, and construct their realization structures.
- Develop an algorithm using DSP Processor for signal processing applications

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	1	1	-	-	-	-	-	-	-	-	2	1
2	2	3	3	1	-	-	-	-	-	-	-	-	2	1
3	2	3	3	1	-	-	-	-	-	-	-	-	2	1
4	2	3	3	1	-	1	-	-	-	-	-	-	2	1
5	1	2	1	1	-	1	-	-	-	-	-	-	2	1

**UNIT I****10 Hours****SIGNALS AND SYSTEMS**

Classification of Systems: Continuous, Discrete, Linear, Causal, Stability, Dynamic, Recursive, Time Variance Systems; Classification of Signals: Continuous and Discrete, Energy and Power; Mathematical representation of Signals; Spectral Density; Sampling techniques, Quantization, Quantization error, Nyquist rate, Aliasing effect

**UNIT II****9 Hours****DISCRETE TIME SYSTEM ANALYSIS**

Z-transform and its properties, Inverse Z-transforms; Difference equation - Solution by Z-transform, Application to Discrete Systems - Stability analysis, Frequency response - Convolution - Discrete Time Fourier transform, Magnitude and Phase representation

**UNIT III****8 Hours****DISCRETE FOURIER TRANSFORM**

Discrete Fourier Transform- properties, magnitude and phase representation - Computation of DFT using FFT algorithm - DIT & DIF using radix 2 FFT - Butterfly structure

**UNIT IV****10 Hours****DESIGN OF DIGITAL FILTERS**

FIR & IIR filter realization - Parallel & Cascade forms. FIR design: Windowing Techniques - Need and choice of windows - Linear phase characteristics. Analog filter design - Butterworth and Chebyshev approximations; IIR Filters, Digital design using impulse invariant and bilinear transformation Warping, prewarping

**UNIT V****8 Hours****DIGITAL SIGNAL PROCESSORS**

Introduction - Architecture - Features - Addressing Formats - Functional modes - Dedicated MAC unit - Multiple ALUs, Pipelining - Introduction to Commercial DS Processors

**FOR FURTHER READING**

Lattice structure of IIR and FIR filters, Kaiser Window, Quantization error in FFT algorithm, Applications of Multirate systems, Architecture of TMS320C6X, C0ode composer studio

**Total: 60 Hours****Reference(s)**

1. J.G. Proakis and D.G. Manolakis, 'Digital Signal Processing Principles, Algorithms and Applications', Pearson Education, New Delhi, PHI, 2007
2. S.K. Mitra, 'Digital Signal Processing - A Computer Based Approach', McGraw Hill Edu, 2013
3. Tarun Kumar Rawat, Digital Signal Processing, Oxford University Press, 2015
4. Richard G. Lyons, Understanding Digital Signal Processing, Prentice Hall, 3rd Edition, 2012
5. S. Salivahanan, A.Vallavaraj, Gnanapriya, Digital Signal Processing, McGraw-Hill, 2nd Edition, 2011

**21EE607 MICROCONTROLLERS BASED SYSTEM****DESIGN LAB****0021****Course Objectives**

- To understand the instruction sets of different microcontrollers.
- To gain hands-on experience on various microcontrollers.
- To interface the microcontroller for given applications.
- To develop an Integrated Development Environment (IDE) for embedded system.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- 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.
- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 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.
- 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.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Design and execute a simple program using PIC, ARM & MSP430 controllers.
- Implement and analyze the interfacing of peripherals devices with PIC, ARM & MSP430 controllers.
- Analyze the peripheral interfacing of analog and digital Sensors in microcontrollers.
- Execute analog to digital conversion using PIC16F877a and MSP430.
- Implement and analyze the interfacing of stepper motor with PIC, ARM & MSP430 controllers.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	-	3	-	2	-	-	-	2	2	2	1	3	2
2	3	-	3	-	2	-	-	-	2	2	2	1	2	2
3	2	-	3	-	2	-	-	-	2	2	2	1	1	2
4	3	-	3	-	2	-	-	-	2	2	2	1	2	2
5	2	-	3	-	3	-	-	-	2	2	2	1	2	3

<b>1</b>		<b>14 Hours</b>
<b>EXPERIMENT 1</b>		
Simple programming to design Flashing LED with PIC 16F877A.		
<b>2</b>		<b>4 Hours</b>
<b>EXPERIMENT 2</b>		
Implementation and interfacing of LCD with PIC16F877a.		
<b>3</b>		<b>2 Hours</b>
<b>EXPERIMENT 3</b>		
Implementation and interfacing of stepper motor		
<b>4</b>		<b>2 Hours</b>
<b>EXPERIMENT 4</b>		
Implementation and interfacing of LM35 Temperature Sensor.		
<b>5</b>		<b>2 Hours</b>
<b>EXPERIMENT 5</b>		
Generation of PWM pulse to control DC motor using PIC16F877a.		
<b>6</b>		<b>4 Hours</b>
<b>EXPERIMENT 6</b>		
Simple programming to design Flashing LED with PIC 18FXXX.		
<b>7</b>		<b>4 Hours</b>
<b>EXPERIMENT 7</b>		
Flashing of LEDs using ARM LPC2148.		
<b>8</b>		<b>2 Hours</b>
<b>EXPERIMENT 8</b>		
Interfacing of Relay with ARM LPC2148.		
<b>9</b>		<b>4 Hours</b>
<b>EXPERIMENT 9</b>		
Basic Input and Output Using MSP430.		
<b>10</b>		<b>2 Hours</b>
<b>EXPERIMENT 10</b>		
Analog to Digital Conversion and Interrupts Using MSP430.		
		<b>Total: 30 Hours</b>

**Course Objectives**

- Students will be able to analyse the performance of DC- DC converters.
- Students will be able to analyze the performance of Inverters.
- Students will be able to analyse the performance of Permanent magnet synchronous motor.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- 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.
- 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.
- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Design and analyze the performance characteristics of converter for solar PV applications.
- Design and analyze the performance characteristics of inverter for UPS applications.
- Analyze the performance characteristics of AC voltage controller for the speed of fans, pumps, and hoists.
- Analyze the performance characteristics of Switched reluctance motor drive for industrial applications.
- Design, Simulate and analyze the characteristics of Permanent magnet synchronous motor for Electric vehicle.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	3	1	2	1	-	-	2	2	-	-	1	1
2	3	2	3	1	2	1	-	-	2	2	-	-	3	3
3	3	2	-	2	2	1	-	-	2	2	-	-	3	3
4	2	2	-	2	2	1	-	-	2	2	-	-	2	3
5	1	2	3	2	2	1	-	-	2	2	-	-	3	1

**1****3 Hours****EXPERIMENT 1**

Verification of single phase half and fully controlled converters.

**2****3 Hours****EXPERIMENT 2**

Experimental verification of Boost regulator with TPS55340 and LM5122 ICs and Low-dropout Regulators with TPS7A4901 and TPS7A8300.

**3****2 Hours****EXPERIMENT 3**

Verification of TPS54160 buck regulator and LM3475 hysteretic buck regulator.

<b>4</b>		<b>2 Hours</b>
<b>EXPERIMENT 4</b>		
Verification of single phase AC voltage controller.		
<b>5</b>		<b>4 Hours</b>
<b>EXPERIMENT 5</b>		
Experimental verification of multilevel inverter		
<b>6</b>		<b>4 Hours</b>
<b>EXPERIMENT 6</b>		
Verification of three phase voltage source inverter and V/f control of three phase VSI fed Induction motor drive.		
<b>7</b>		<b>3 Hours</b>
<b>EXPERIMENT 7</b>		
Four quadrant operation of DC motor using chopper.		
<b>8</b>		<b>2 Hours</b>
<b>EXPERIMENT 8</b>		
Switched reluctance motor drive.		
<b>9</b>		<b>3 Hours</b>
<b>EXPERIMENT 9</b>		
Simulation of Permanent magnet synchronous motor Using MATLAB Software for Electric Vehicle.		
<b>10</b>		<b>4 Hours</b>
<b>EXPERIMENT 10</b>		
Simulation of Permanent magnet synchronous motor Using MATLAB Software for Electric Vehicle.		
		<b>Total: 30 Hours</b>

**21HS002 PROFESSIONAL ETHICS IN ENGINEERING****2002****Course Objectives**

- Understand the concept of good values and comprehend the importance of value-based living.
- Recognize the culture of peace through education.
- Identify and apply the practices for value development and clarification.

**Programme Outcomes (POs)**

- h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- j. 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.

**Course Outcomes (COs)**

1. Understand the importance of human values and ethics in life.
2. Execute the importance of harmonious living in a diverse society.
3. Analyze the sensitivity to the crying needs of society such as ungodliness, corruption, poverty, and suffering, and play a vital role in eradicating them.
4. Plan intellectually mature, morally upright, ethically correct, and spiritually inspired decisions.
5. Execute a correct balance between professional excellence and social commitment.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	3	2	2	-	-	-	-
2	-	-	-	-	-	-	-	3	2	2	-	-	-	-
3	-	-	-	-	-	-	-	3	2	2	-	-	-	-
4	-	-	-	-	-	-	-	3	2	2	-	-	-	-
5	-	-	-	-	-	-	-	3	2	2	-	-	-	-

**UNIT I****6 Hours****COURSE INTRODUCTION - NEED, BASIC GUIDELINES AND ANALYSIS**

Importance of Human Values & Ethics in 21st Century-Understanding the theory of basic human values and ethics - Openness to change - Self-enhancement - Conservation - Self-transcendence -Schwartz Value Survey: Self-Assessment

**UNIT II****6 Hours****EMBRACING THE COMMON ETIQUETTE**

Altruism – Integrity -Freedom -Justice -Honesty -Truthfulness -Responsibility –Compassion

**UNIT III****6 Hours****CONTINUOUS HAPPINESS AND PROSPERITY**

An overview on basic Human Aspirations - Understanding and living in harmony at various levels of life -Embracing self-love and wellness -Understanding harmony in the family and society

**UNIT IV****6 Hours****UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS**

Reflection on growing global multifold problems: poverty, pollution, hunger, disease, unemployment, caste system, child labour, gender equality, politics and violence. Understanding the challenges in cultural, personal, social, political, and economic environment

**UNIT V**

**6 Hours**

**UNDERSTANDING HARMONY IN THE NATURE AND EXISTENCE - WHOLE EXISTENCE AS CO-EXISTENCE**

Understanding the harmony in the Nature - Holistic perception of harmony at all levels of existence - Practice Exercises and Case Studies will be taken up in Practice Sessions

**FOR FURTHER READING**

Sample code of ethics like IETE, ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management.

**Total: 30 Hours**

**Reference(s)**

1. Martin, G. (2011). The Little Book of Ethics: A Human Values Approach. Australia: G.P. Martin.
2. Gupta, N. L. (2002). Human Values for The 21St Century. India: Anmol Publications Pvt. Limited.
3. Mishra, A. (2017). Happiness Is All We Want. India: Bloomsbury Publishing.
4. Universal Human Values. (2023). (n.p.): Booksclinic Publishing.
5. A Textbook on Professional Ethics and Human Values. (2007), India: New Age International (P) Limited.

**Course Objectives**

- To analyze the motor and load dynamics also predict the steady state stability of drives for different loads.
- To Apply power electronic converters to control the speed of DC motors.
- To analyze various speed control techniques and converter topologies for induction motor drives
- To analyze the performance of synchronous motor drives.
- To select the special electrical machines and control schemes for various industrial applications

**Programme Outcomes (POs)**

- b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- j. 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.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Apply steady state stability principles to drives operating under different load conditions.
2. Analyze the steady state and transient performances of DC drives in constant speed control applications.
3. Analyze the various speed control techniques and converter topologies for effective control of induction motor drives.
4. Analyze the performance of synchronous motor drives in constant speed and low speed application.
5. Select suitable electrical machines and their control schemes for various industrial applications.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	1	-	2	-	-	1	2	2	-	-	1	1
2	3	3	1	-	2	-	-	1	2	2	-	-	2	1
3	3	3	1	-	2	-	-	1	2	2	-	-	2	1
4	3	1	1	-	2	-	-	1	2	2	-	-	2	1
5	3	1	1	-	2	-	-	1	2	2	-	-	2	2

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

Development of Electric Drives - Drive classifications - Advantage of Electric Drives - Equations governing motor load dynamics - Equilibrium operating point and its steady state stability - Mathematical condition for steady state stability and problems - Nature and classification of load torque Multi-quadrant operation.

**UNIT II****8 Hours****CONVERTER / CHOPPER FED DC MOTOR DRIVE**

DC motor and their performance - Braking - 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 - Dynamic braking with DC chopper - Four Quadrant operation - Chopper fed regenerative braking.

**UNIT III****11 Hours****INDUCTION MOTOR DRIVES**

Analysis and performance of three-phase induction motor - Stator voltage - stator frequency control - V/F control, controlled current and controlled slip operation - PWM inverter drives - Voltage Source Inverter, Current Source Inverter and cycloconverter fed induction motor drives - Harmonic behavior of induction motors - Rotor slip power recovery schemes.

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

Principle of vector control - Open loop v/f control - self controlled synchronous motor drive using load commutated thyristor inverter - self-control of CSI and VSI fed synchronous motor - Margin angle control and power factor control - Permanent magnet (PM) synchronous motor.

**UNIT V****8 Hours****BLDC, STEPPER MOTOR DRIVES AND APPLICATIONS**

Brushless DC motor drives and its applications - Variable reluctance and permanent magnet stepper motor Drives - Selection of drives and control schemes for steel rolling mills, paper mills, shipping - PLL, PID based control of drives - Closed loop control of BLDC Drives-Development of sensor less BLDC motor control scheme using PIC Controller.

**Total: 45 Hours****Reference(s)**

1. Krishan.R ,Permanent Magnet Synchronous and Brushless DC Motor Drives, CRC Press ,2017.
2. Vedam Subramanyam, Electric Drives: Concepts & Applications, Tata McGraw- Hill Education, 2017.
3. Soumitra Kumar Mandal, Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085, 8086, 8051, McGraw Hill Education, 2013.
4. P.S.Bimbra Power Electronics, Khanna Publishers, third Edition, 2003.
5. Ned Mohan, Power Electronics, John Wiley and Sons, 2019.
6. Bimal K. Bose, Power Electronics and Motor Drives: Advances and Trends, Academic Press, 2017.

**21EE707 SOLID STATE DRIVES LABORATORY****0 0 2 1****Course Objectives**

- To analyse the performance of DC drives.
- To analyze the closed loop controller of BLDC motor .
- To analyze the speed control methods of AC drives.
- To apply power electronic converters to control the speed of DC motors.
- To analyze various speed control techniques for SRM drives.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- 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.
- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Design and analyze the closed loop control of DC motor and BLDC motor.
- Analyze the four quadrant operation of DC motor drive.
- Analyze the speed control methods of induction motor and SRM motor drives.
- Analyze the performance characteristics of cycloconverter and CSI fed AC drive.
- Design, Simulate and analyze the speed control methods of SRM motor drive.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	1	-	2	-	-	1	2	2	-	-	1	1
2	3	3	1	-	2	-	-	1	2	2	-	-	2	1
3	3	3	1	-	2	-	-	1	2	2	-	-	2	1
4	3	1	1	-	2	-	-	1	2	2	-	-	2	1
5	3	1	1	-	2	-	-	1	2	2	-	-	2	2

**1****4 Hours****EXPERIMENT 1**

Design a speed control method for controlling the speed of the washing machine.

**2****3 Hours****EXPERIMENT 2**

Design a speed control method for three phase Induction Motors in winches.

<b>3</b> <b>EXPERIMENT 3</b> Design a PWM inverter fed three phase Induction Motors used in lathes.	<b>3 Hours</b>
<b>4</b> <b>EXPERIMENT 4</b> Speed control of the three phase Induction Motors in ball mills using V/f control.	<b>3 Hours</b>
<b>5</b> <b>EXPERIMENT 5</b> Design a torque control method for three phase Induction Motors in screw presses.	<b>3 Hours</b>
<b>6</b> <b>EXPERIMENT 6</b> Design a microcontroller based control of BLDC motors in electric vehicles.	<b>3 Hours</b>
<b>7</b> <b>EXPERIMENT 7</b> Design a speed control method for SRM in conveyors.	<b>3 Hours</b>

**Total: 30 Hours**

**Reference(s)**

1. Rajkamal, Embedded System-Architecture, Programming, Design, Mc Graw Hill, 2013.
2. Peckol, Embedded system Design, John Wiley & Sons, 2010.
3. Lyla B Das, Embedded Systems-An Integrated Approach, Pearson, 2013.

## 21EE708 PROJECT WORK I

0 0 6 3

### Course Objectives

- Formulate a real world problem, identify the requirement and develop the design solutions.
- Identify technical ideas, strategies and methodologies
- Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project
- Test and validate through conformance of the developed prototype and analysis the cost effectiveness
- Prepare report and present oral demonstrations

### Programme Outcomes (POs)

- Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- 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.
- Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- 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.
- 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.
- Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 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.
- Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Develop the solutions for real world problems
2. Develop the technical ideas, strategies and methodologies to solve the real world problems
3. Apply the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the costeffectiveness.
5. Prepare report and present oral demonstrations

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	3	2	-	-	2	1	-	-	-	-	-	3	1
2	2	2	1	3	-	2	-	-	-	-	2	2	2	-
3	-	-	3	2	2	-	-	2	-	-	2	2	3	-
4	-	1	-	2	3	1	2	2	-	-	-	-	1	3
5	-	-	-	-	-	-	-	-	3	3	-	2	-	3

**21EE801 PROJECT WORK II****00189****Course Objectives**

- Formulate a real world problem, identify the requirement and develop the design solutions.
- Identify technical ideas, strategies and methodologies
- Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project
- Test and validate through conformance of the developed prototype and analysis the cost effectiveness
- Prepare report and present oral demonstrations

**Programme Outcomes (POs)**

- a. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. **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.
- d. **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.
- e. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- f. **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.
- g. **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.
- h. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- i. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- j. **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.
- k. **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- l. **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.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Develop the solutions for real world problems
2. Develop the technical ideas, strategies and methodologies to solve the real world problems
3. Apply the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the costeffectiveness.
5. Prepare report and present oral demonstrations

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	2	-	2	1	-	3	-	-	-	3	1
2	2	2	2	3	-	2	-	-	3	-	2	2	2	-
3	-	-	3	2	2	-	1	2	3	-	2	2	3	-
4	-	1	-	2	3	2	2	2	3	-	3	-	1	3
5	-	-	-	-	-	-	-	-	3	3	2	2	1	3

**18HS201 COMMUNICATIVE ENGLISH II****1 0 2 2****Course Objectives**

- Read and understand ideas of complex text on both concrete and abstract topics
- Listen and understand technical discussions in his/her field of specialisation
- Produce clear, detailed text on a wide range of subjects and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options
- Interact with a degree of fluency and spontaneity that makes regular interaction without strain

**Programme Outcomes (POs)**

- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems

**Course Outcomes (COs)**

- Apply appropriate grammar & vocabulary that is expected at the BEC Vantage exam level.
- Analyse the general meaning of non-routine letters, and of a report of predictable / unpredictable topic.
- Execute the simple reports of factual nature and factual non-routine letters.
- Implement for factual information and understand the answer; and take/pass on workplace messages.
- Analyse express opinions and present arguments to a limited extent; and give simple, prepared presentations on familiar topics.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	1	-	-	-	1	-
2	-	-	-	-	-	-	-	-	2	-	-	-	1	-
3	-	-	-	-	-	-	-	-	3	-	-	-	1	-
4	-	-	-	-	-	-	-	-	-	1	-	-	1	-
5	-	-	-	-	-	-	-	-	-	2	-	-	1	-

**UNIT I****9 Hours****GRAMMAR**

Tenses - Future continuous, Future perfect, Future perfect continuous, Past perfect, Past perfect continuous - Adjectives and adverbs - Mixed conditionals - Modals - can't have, needn't have - Modals of deduction and speculation - Narrative tenses - Passives - Phrasal verbs, extended - Relative clauses - Reported speech - Will and going to, for prediction - Wish - Would expressing habits, in the past.

**UNIT II****9 Hours****READING**

Scanning and reading for gist - Understanding text structure - Reading for gist and specific information - Vocabulary and structure - Understanding sentence structure and error identification

**UNIT III****9 Hours****WRITING**

A message, memo or email, Giving instructions, explaining a development, asking for comments, requesting information, agreeing to requests - Business correspondence: explaining, apologising, reassuring, complaining, short report: describing, summarising - proposal: describing, summarising, recommending, persuading.

**UNIT IV**

**9 Hours**

**LISTENING**

Listening for and noting specific information - Listening to identify topic, context, Function - Following the main points and retrieving specific information from the text.

**UNIT V**

**9 Hours**

**SPEAKING**

Giving personal information: Talking about present circumstances, past experiences and future plans, expressing opinions, speculating - Organising a larger unit of discourse: Giving information and expressing and justifying opinions - Turn-taking: negotiating, collaborating, exchanging information, expressing and justifying opinions, agreeing/disagreeing, suggesting, speculating, comparing and contrasting, and decision-making.

- 1.A Horse and Two Goats - R K Narayan
- 2.My Lord the Baby - Rabindranath Tagore
- 3.Twist in the Tale - Jeffery Archer
4. The Third and Final Continent - Jhumpa Lahiri
- 5.The Gift of the Magi - O Henry

**Total: 45 Hours**

**Reference(s)**

1. Guy Brook-Hart, "BEC Vantage: Business Benchmark Upper-Intermediate- Student's Books" 1st Edition, Cambridge University Press, New Delhi, 2006.
2. Ian Wood, Paul Sanderson, Anne Williams with Marjorie Rosenberg, "Pass Cambridge BEC Vantage- Student's Book" 2nd Edition, Cengage Learning, New Delhi, 2014
3. Michael Handford, Martin Lisboa, Almut Koester, Angela Pitt, "Business Advantage - Student's Book Upper-Intermediate" Cambridge University Press, New Delhi, 2014.
4. Cambridge Examinations Publishing, "Cambridge BEC VANTAGE - Self-study Edition", Cambridge University Press, UK, 2005.

**18HSH01 HINDI****1 0 2 2****Course Objectives**

- To help students acquire the basics of Hindi
- To teach them how to converse in Hindi on simple day-to-day situations
- To help students acquire the ability to understand a simple technical text in Hindi

**Programme Outcomes (POs)**

- j. **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.

**Course Outcomes (COs)**

1. Apply simple sentences and use vocabulary required for day-to-day conversation.
2. Distinguish and understand the basic sounds of Hindi language.
3. Evaluate to appear for Hindi examinations conducted by Dakshin Bharat Hindi Prachar Sabha.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	-	2	-	-	-	-
2	-	-	-	-	-	-	-	-	-	2	-	-	-	-
3	-	-	-	-	-	-	-	-	-	3	-	-	-	-

**UNIT I****9 Hours**

Hindi Alphabet: Introduction - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - Vowel Signs - Chandra Bindu & Visarg -Table of Alphabet -Vocabulary.

**UNIT II****9 Hours**

Nouns: Genders (Masculine & Feminine Nouns long vowels and short vowels - -Masculine & Feminine - Reading Exercises.

**UNIT III****9 Hours**

Pronouns and Tenses: Categories of Pronouns - Personal Pronouns - Second person (you & honorific) - Definite & Indefinite pronouns - Relative pronouns - Present tense - Past tense - Future tense - Assertive & Negative Sentences - Interrogative Sentences.

**UNIT IV**

Classified Vocabulary: Parts of body - Relatives - Spices - Eatables - Fruit & Vegetables - Clothes - Directions - Seasons - Professions.

**UNIT V****9 Hours**

Speaking: Model Sentences and Rhymes - Speaking practice for various occasions.

**Total: 45 Hours****Reference(s)**

1. Hindi Prachar Vahini-1 by Dakshin Bharat Hindi Prachar Sabha Chennai
2. B.R. Kishore, Self Hindi Teacher for Non-Hindi Speaking People, Vee Kumar Publications(P)Ltd., New Delhi, 2009
3. Videos, Stories, Rhymes and Songs

**18HSG01 GERMAN****1 0 2 2****Course Objectives**

- To help students appear for the A1 level Examination
- To teach them how to converse fluently in German in day-to-day scenarios

**Programme Outcomes (POs)**

j. 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.

**Course Outcomes (COs)**

1. Analyse the listening skill and identify individual sounds of German
2. Apply basic sounds and words while speaking
3. Evaluate the read and understanding skills using short passages on familiar topics
4. Apply basic sentence structures while writing
5. Analyse the useage of basic grammar and appropriate vocabulary in completing language tasks

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	-	2	-	-	-	-
2	-	-	-	-	-	-	-	-	-	2	-	-	-	-
3	-	-	-	-	-	-	-	-	-	3	-	-	-	-
4	-	-	-	-	-	-	-	-	-	2	-	-	-	-
5	-	-	-	-	-	-	-	-	-	3	-	-	-	-

**UNIT I****9 Hours**

Introduction to German language: Alphabet - Numbers - Greetings - Days and Seasons- Working with Dictionary.

**UNIT II****9 Hours**

Nouns - articles - Speaking about one self - Listening to CD supplied with the books, paying special attention to pronunciation

**UNIT III****9 Hours**

Regular & Irregular verbs - Personal pronouns - family - Introduction to types of sentences

**UNIT IV****9 Hours**

Question words-Types of Questions - Nominative case- Verb Conjugation - country – nationalities

**UNIT V****9 Hours**

Verbs - to be & to have - conjugation - Hobbys - Framing basic Questions and answers

**Reference(s)****Total: 45 Hours**

1. Kursbuch and Arbeitsbuch, NETZWERK A1 DEUTSCH ALS FREMDSPRACHE, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2015
2. Langenscheidt Eurodictionary - German - English / English - German, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2009
3. Grundkurs, DEUTSCH Lehrbuch Hueber Munichen, 2007.

**18HSJ01 JAPANESE****1 0 2 2****Course Objectives**

- To train students for N5 Level Examination
- To teach them use basic Japanese sentences in day-to-day conversation
- To make students familiar with the Japanese cultural facets and social etiquettes

**Programme Outcomes (POs)**

j. 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.

**Course Outcomes (COs)**

1. Apply the Japanese alphabet while writing a letter
2. Apply the basic sounds of the Japanese language while Speaking
3. Apply appropriate vocabulary needed for simple conversation in Japanese language
4. Apply appropriate grammar to write and speak in Japanese language
5. Comprehend the conversation and give correct meaning

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	-	2	-	-	-	-
2	-	-	-	-	-	-	-	-	-	2	-	-	-	-
3	-	-	-	-	-	-	-	-	-	2	-	-	-	-
4	-	-	-	-	-	-	-	-	-	2	-	-	-	-
5	-	-	-	-	-	-	-	-	-	2	-	-	-	-

**UNIT I****9 Hours**

Introduction to Japanese - Japanese script- Pronunciation of Japanese(Hiragana)- (Katakana) Long vowels - Pronunciation of in,tsu,ga - Letters combined with ya,yu,yo - Daily Greetings and Expressions - Numerals. N1 wa N2 desu - N1 wa N2 ja arimasen - S ka N1 mo - N1 no N2 - san - Kore - Sore - Are - Kono N - Sono N - Ano N - Sou desu - Sou ja Arimasen - S1 ka - S2 ka - N1 no N2 - Sou desu ka - Koko - Soko - Asoko - Kochira - Sochira Achira - N1 wa N2 (place) desu - Doko - Dochira - N1 no N2 - Ko - So - A - Do ( Demonstrative words) - O kuni Kanji10 - Technical Japanese Vocabulary (30 Numbers)

**UNIT II****9 Hours**

Introduction to time - Ji - Fun - Pun - Introduction of verbs - V Masu - V Masen - V Mashita - V Masendeshita N (Time) Ni V - N1 Kara - N2 Made - N1 to N2 - S Ne - N (Place) e Ikimasu - Kimasu - Kaerimasu - Doko (e) Mo Ikimasen - Ikimasendeshita - N (Vehicle) de Ikimasu - Kimasu - Kaerimasu - N (Person / Animal) to V - Itsu - S Yo N o (transitive) - N o Shimasu - Nani o Shimasuka - Nan and Nani - N (place) de V - V Masenka - V Mashou - o - Kanji 10 - Technical Japanese Vocabulary (30 Numbers) .

**UNIT III****9 Hours**

N (tool/means) de V - Word/Sentence wa Go de Nani desu ka - N (person) Ni Agemasu, etc - N (person) Ni Moraimasu etc - Mou V Mashita - Introduction to Adjectives - N wa Na adj (Na) desu - N wa II adj (II) desu - Na adj Na n - II adj (II) N - Totemo - Amari - N wa Dou desuka - N1 wa Donna N2 desuka - S1 Ga S2 - Dore N ga Arimasu - Wakarimasu - N Ga Sukidesu - Kiraidesu - Jozu desu - Heta desu - Donna N - Yoku - Daitai - Takusan - Sukoshi - Amari - Zenzen - S1 kara S2 - Doushite - Kanji 10 - Technical Japanese Vocabulary (30 Numbers)

**UNIT IV**

**9 Hours**

N ga Arimasu - Imasu - N1 (place) Ni N2 ga Arimasu - Imasu - N1 (thing/person/place) no N2 (position) - N1 ya N2 - Word (s) desuka - Chirisosu wa Arimasuka - Saying numbers - Quantifier (period) Ni kai V - Quantifier Dake - N dake - Past tense of Noun sentences and Na adjective sentences - Past tense of ii adjective sentences - N1 wa N2 yori adjective desu - N1 to N2 to dochira ga adjective desu ka - N1/N2 no houga adjective desu - Kanji 10 - Technical Japanese Vocabulary (30 Numbers)

**UNIT V**

**9 Hours**

N ga hoshi desu - V masu form tai desu - N (place) e V masu form - N Ni - ikimasu - kimasu - kaerimasu N ni V - N o V - dou ko ka - nani ka - go chuu mon - Verb conjugation - Verb groups - Verb te form - V te form kudasai - V te form imasu - V masu form mashouka - S1 ga S2 - N ga V - V te form mo ii desu - V te form wa ikemasen - V te form imasu Shrimasen - Kanji 10 - Technical Japanese Vocabulary (30 Numbers)

**Total: 45 Hours**

**Text Book(s)**

1. Japanese for Everyone: Elementary Main Textbook 1-2, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

**Reference(s)**

1. Japanese for Everyone: Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

**18HSC01 CHINESE****1 0 2 2****Course Objectives**

- To help students appear for HSK Level 1 Exam
- To help students acquire the basics of Chinese language
- To teach the students how to converse in Chinese in various situations

**Programme Outcomes (POs)**

j. 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.

**Course Outcomes (COs)**

1. Apply the listening skills to identify individual sounds of Chinese
2. Apply the basic sounds and words while speaking
3. Analyse the reading and understanding skills using short passages on familiar topics
4. Apply the basic sentence structures while writing
5. Apply the basic grammar and appropriate vocabulary in completing language tasks

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	-	2	-	-	-	-
2	-	-	-	-	-	-	-	-	-	2	-	-	-	-
3	-	-	-	-	-	-	-	-	-	3	-	-	-	-
4	-	-	-	-	-	-	-	-	-	2	-	-	-	-
5	-	-	-	-	-	-	-	-	-	3	-	-	-	-

**UNIT I****9 Hours**

Hello | 1.Initials and Finals of Chinese | b,p,m,f,d,,n,l,g,k,h,j,q,x | 2. Tones Four | 3.Chinese Syllables | 4.Tone S

**UNIT II****9 Hours**

Thank you | Initials and Finals of Chinese | The Neutral Tone | Rules of Tone Marking and Abbreviation

**UNIT III****9 Hours**

1. What's your name - In the school; -In the classroom; -In the school | The Interrogative Pronoun | 2 The Sentence | 3 Interrogative Sentences with

**UNIT IV****9 Hours**

She is my Chinese teacher | In the library | The Interrogative Pronouns | The Structural Particle | The interrogative Particle

**UNIT V****9 Hours**

Her daughter is 20 years old this year | 1.The Interrogative Pronoun | 2. Numbers below 100 | 3.Indicating a Change | The Interrogative Phrase

**Total: 45 Hours**

**18HSF01 FRENCH****1 0 2 2****Course Objectives**

- To prepare the students for DELF A1 Examination
- To teach them to converse fluently in French in day-to-day scenarios

**Programme Outcomes (POs)**

j. 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.

**Course Outcomes (COs)**

1. Apply the French alphabet & basic vocabulary skills while writing and speaking
2. Apply the individual sounds of French while speaking
3. Apply the basic sounds and words while speaking
4. Analyse the Reading and understanding skills of French using short passages on familiar topics
5. Apply the basic grammar and appropriate vocabulary in completing language tasks

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	-	2	-	-	-	-
2	-	-	-	-	-	-	-	-	-	2	-	-	-	-
3	-	-	-	-	-	-	-	-	-	3	-	-	-	-
4	-	-	-	-	-	-	-	-	-	2	-	-	-	-
5	-	-	-	-	-	-	-	-	-	3	-	-	-	-

**UNIT I****9 Hours****ENTRER EN CONTACT**

La langue française, alphabets, les numeros, les jours, les mois. Grammaire Les verbes s'appeler, être, avoir, les articles définis, indéfinis Communication - Saluer, s'informer sur quelqu'un, demander de se présenter Lexique - Les alphabets, les nationalités, âge, les pays, les couleurs, les jours de la semaine, les mois de l'année, les professions

**UNIT II****9 Hours****PARTAGER SON LIEU DE VIE**

Les français et leur habitat, des habitations insolites Grammaire - Verbes - Conjugaison : Présent (Avoir / être / ER, IR, RE : Régulier et Irrégulier) - Adjectifs les propositions de lieu Communication - Chercher un logement, s'écrire son voisin, s'informer sur un logement Lexique - L'habitat, les pièces, l'équipement, la description physique

**UNIT III****9 Hours****VIVRE AU QUOTIDIEN**

Grammaire - Articles contractés, verbes vouloir, pouvoir, devoir, adjectif interrogative, future proche Communication- Exprimer ses goûts, parler de ses loisirs, justifier un choix, exprimer une envie Lexique - le temps libre et les loisirs, les saisons, les activités quotidiennes, le temps (le matin, le soir, la nuit)

**UNIT IV**

**9 Hours**

**COMPRENDRE SON ENVIRONNEMENT LA CULTURE**

Grammaire - Verbes - Finir, Sortir, les adjectifs demonstratifs, le passe compose, l'imparfait

Communication - Propose aÃƒfÃ,Ã,Ã quelqu'un de faire quelque chose, raconteur une sortie au passe parler un film  
Lexique - Les sorties, la famille, art, les vetements et les accessoires

**UNIT V**

**9 Hours**

**GOUTERA LA CAMPAGNE**

Grammaire La forme negative, les verbes acheter, manger, payer, articles partitifs, le pronom en de quantite

Communication Accepter et refuse rune invitation, donner des instructions, commander au restaurant

Lexique Les services et les commerces, les aliments, les ustensiles, argent

**Total: 45 Hours**

**Reference(s)**

1. Saison A1, Methode de francais
2. Hachette FLE

**18EE0XA EMBEDDED CONTROL OF ELECTRIC****DRIVES****0001****Course Objectives**

- To provide introduction on Electric drives and their purposes
- To bring awareness about basic elements of automation - Sensing, Actuation and Control.

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- c. 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.
- d. 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.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Analyze the AC drives, DC drives and servo drives
2. Analyze the various controllers and sensing units for Electric drives

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	-	2	3	-	-	-	-	-	-	-	-	1	-
2	3		2	1	-	-	-	-	-	-	-	-	1	1

**UNIT I**

Introduction to Electric Drives AC Drives, DC Drives, Servo Drives Selection of Electric Drives as per application, Basic components of Drives Control Introduction to Controllers : PLC, Microcontrollers Introduction to Sensing Circuits Basic Control Algorithms: On/Off Control, Hysteresis Control, P, PI, PID control Control of AC Drives - VFD and TRIAC Firing Angle control. Control of DC Drives - PWM Control Bi-Directional Control using DIR input Position Control using Encoders Voltage and Current Control Fault Detection

**Reference(s)**

1. Vedam Subramanyam, "Electric Drives: Concepts and Applications", Tata McGraw-Hill, New Delhi, 2004.
2. Hamid A. Toliyat, "DSP Based Electromechanical Motion Control", 1st Edition, CRC Press, 2004.

## 18EE0XB DESIGN OF EMBEDDED SYSTEM FOR DC MOTOR CONTROL

0001

### Course Objectives

- To introduce Motor Control Applications and chip-sets available in market
- To bring awareness about basic elements of automation - Sensing, Actuation and Control

### Programme Outcomes (POs)

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- d. 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.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

### Course Outcomes (COs)

1. Analyze the motor control using embedded system.
2. Select suitable controller for Dc motor control .

### Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1		2	3	-	-	-	-	-	-	-	-	1	-
2	1	2		3	-	-	-	-	-	-	-	-	1	-

### UNIT I

15 Hours

#### DESIGN OF EMBEDDED SYSTEM FOR DC MOTOR CONTROL

Introduction to Motor Control Differences between DC, BLDC, Stepper and Servo Motors  
Microcontrollers – Basics Motor control Peripherals, ADC, Digital Ports, PWM, Capture Unit, Compare Unit, Comparison of Microcontrollers for Motor Control in the market, TI, ST, Atmel, Microchip  
Selection of External Motor Control Drivers, Importance of Optocouplers, Over Voltage / Current detection  
PWM control basics Current Sensing Circuit and Current Control Bi-Directional Control using H-Bridges  
Position Control using Encoders Fault Detection

TOTAL:15 Hours

### Reference(s)

1. Ion Boldea and Nasar S A, "Electric Drives", CRC Press LLC, New York, 2005.
2. Bose B K, "Modern Power Electronics and AC Drives", Pearson Education, New Delhi, 2003.

**18EE0XC INDUSTRIAL AUTOMATION****0 0 0 1****Course Objectives**

- To understand the various Industrial Measurement techniques
- To analyze about various configurations of PLC.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Analyze the various Measurement techniques for industrial automatiuon.
- Analyze the various architectures of PLC & SCADA.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	-	2	-	3	-	-	-	-	-	-	-	2	1
2	1	2	3	-	--	-	-	-	-	-	-	-	2	1

**UNIT I**

Introduction to Instrumentation Basics, Instrumentation Standards, Introduction to Industrial Measurement techniques : Pressure Measurement, Temperature Measurement, Flow Measurement, Level Measurement, Basic Control Loops and Tuning, Introduction to Field Instruments, Principle and Operation of Transmitters, Principle and Operation of Flow meters, Principle and Operation of Control Valves, Single Loop Controllers and Operation, Principle and Operation of Data acquisition System

**UNIT II**

CENTUM VP overview, CENTUM VP system architecture, FCS hardware configuration, HIS configuration, Network details, Address settings, Introduction to CENTUM VP engineering, Project creation, Project attribute utility, IOM creation/ IOM builder settings, Practice session, Creation of open loop, Creation of closed loop, Introduction to FCS simulation, Concept of download : Offline download, Online download, IOM load, System defined windows: Faceplate, Tuning, System defined windows, Practice session

### UNIT III

Creation of cascade loop, Signal selectors, Configuration of FOUT block, Configuration of SPLIT block , Creation of control group window, Creation of trend window, HIS setup window , Scheduler, Practice session, Concept of discrete I/Os, switches, Concept of interlocks, Configuration of sequence table, configuration of logic chart , Configuration of MC-2 block, Configuration of MC-2 in logic chart, TPCFL block, CALCU block, Overview window, Graphics window, Practice session, Introduction PLC concepts Types of PLCs, Difference between DCS and PLC, PLC System Configuration, PLC Hardware Configuration, Prosafe-RS safety PLC-features, hardware details, Introduction to Work bench, Project Creation, Screens of Workbench - Link Architecture

### UNIT IV

Hardware Architecture - I/O Wiring – Dictionary, I/O Variable Creation and Wiring, Introduction to FBD, FBD logic using digital signal, Configuration of SCALER Block, Configuration of FILTER Block, Configuration of MUXREAL4 Block, Configuration of SEL\_R Block, Configuration of ANLG\_S Block, Offline Download/Online download, I/O Lock Window/Forcing Function, Introduction to Integration with CENTUM VP for implementing SCADA, Engineering on SENG Side, Engineering on CENTUM VP Side, Function Blocks for Integration, Introduction to Ladder diagrams, Introduction to Structured text, SOE Viewer

**TOTAL:15 Hours**

### Reference(s)

1. Besterfield D. H. Quality Control. New Jersey, 2001.
2. Goetsch D. L., Davis S. B..Introduction to TQM for production, processing and services. New Jersey: Prentice Hall, 2003

**18EE0XD QUALITY MANAGEMENT SYSTEM**

**0 0 0 1**

**Course Objectives**

- To understand the quality management tools and standards.
- To analyze about product verification methods and quality cost.

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- f. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- k. 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.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Analyze the product verification methods and quality management tools.
2. Analyze the quality standards and quality cost for industrial automation.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	-	-	-	2	-	-	-	-	-	3	-	1	1
2	-	-	-	-	-	1	2	-	-	-	3	-	1	1

**UNIT I**

**PRODUCT VERIFICATION METHODS**

Inspection - Quality control - Quality Assurance - Special process - Six sigma - FMEA – Zero Defects.

**UNIT II**

**BASIC QUALITY MANAGEMENT TOOLS**

Causes and Effect diagram - Check sheet- Control chart - Histogram - Pareto chart -Scatter diagram -Stratification (Flow chart or Run chart).

**UNIT III**

**QUALITY STANDARDS**

ISO-9000 System - Environment Management System - 5S Work Place Management - KANBAN / JIT/ Two Bin System.

#### **UNIT IV**

#### **QUALITY COST**

Cost of Quality - Rework - Rejection - Replacement - Product Failure - Warrantee - Failure Analysis -8D Report.

#### **Reference(s)**

1. Besterfield D. H. Quality Control. New Jersey, 2001.
2. Goetsch D. L., Davis S. B..Introduction to TQM for production processing and services. New Jersey: Prentice Hall, 2003.

**18EE0XE PRODUCT LIFECYCLE MANAGEMENT****0 0 0 1****Course Objectives**

- To understand the Product Life Cycle Management in Industry
- To understand the Product Life Cycle Management in Industry

**Programme Outcomes (POs)**

- g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- k. Demonstrate knowledge and understanding of the engineering and management principles and apply these to own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

**Course Outcomes (COs)**

1. Assess the various features in Product life cycle management
2. Analyze the procedures in the PLM

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	2	-	-	-	3	-	1	-
2	-	-	-	-	-	-	2	-	-	-	3	-	1	-

**Unit-I****Introduction Product Life Cycle Management (PLM)**

Definition, PLM life cycle model, Threats of PLM, Need for PLM, Opportunity & Benefits of PLM, Views, Components & Basics of PLM

**Unit-II****PLM Concepts**

Characteristics of PLM, Environment driving PLM, PLM Elements, Drivers of PLM, Conceptualization, Design, Development, Validation, Production support to PLM.

**Unit-III****Digital Manufacturing of PLM**

Digital manufacturing, Benefits of manufacturing, Virtual learning curve, Manufacturing Rest, Production planning.

**Reference(s)**

1. Grieves Michael, Product Lifecycle Management- Driving the Next Generation of Lean Thinking, McGraw-Hill, 2006.
2. Antti Saaksvuori, Anselmi Immonen, Product Life Cycle Management - Springer, 1st Edition (Nov.5, 2003)
3. Stark, John. Product Lifecycle Management: 21st Century Paradigm for Product Realization, Springer-Verlag, 2004.

**18EE0XF APPLICATIONS OF SYNCHRONOUS GENERATOR IN INDUSTRIES 0 0 0 1**

**Course Objectives**

- To understand about the various tests to be conducted in generators.
- To analyze the open circuit and short circuit characteristics of generator.

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- c. 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.
- d. 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.
- e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Analyze the different offline tests and online tests of generator.
2. Apply the technical standards and grid codes for generator stations.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	-	2	3	-	-	-	-	-	-	-	-	1	2
2	1	-	2	-	3	-	-	-	-	-	-	-	1	2

Introduction to practical aspects of generator testing, Distinction between factory and field tests, Details of electrical tests (test procedure & analysis of results) - Off-Line Tests -Tests on Stator: Insulation Resistance (Polarization Index), Winding Resistance, Core hot-spots, Capacitance & tan-delta, Partial discharge, High voltage, Winding & core temperature detectors - Tests on Field: Insulation Resistance, Winding resistance, Winding impedance, Field short circuit & ground detectors, High voltage, Pole drop test, Magnetization. On-Line Tests - Generator Open-circuit & Short-circuit Characteristics - Step tests for excitation system - Separation tests - Factory acceptance tests - Introduction to Indian Grid Code - Power Scenario in India - Technical standards and Grid codes for generator stations.

**Total: 15 Hours**

**Reference(s)**

1. Ion Boldea, Synchronous Generators, CRC Press, 2nd Edition, Taylor & Francis Group, 2016.
2. M.V. Deshpande, Electrical Machines, PHI Learning, 1st Edition, 2013.
3. Dr Ravi Segal, GE- Energy, Bengaluru.

**18EE0XG REACTIVE POWER MANAGEMENT AND ENERGY STORAGE DEVICES**

0 0 0 1

**Course Objectives**

- To understand the practical aspects of reactive power problem.
- To exemplify the IEEE standards and models for Power System Stabilizers.

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- c. 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.
- d. 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.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Analyze the practical aspects of reactive power problem and sources of reactive power.
2. Analyze the functions of Power System Stabilizers and Energy Storage Devices.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	-	2	3	-	-	-	-	-	-	-	-	1	-
2	1	-	3	2	-	-	-	-	-	-	-	-	1	1

Introduction to the problem of VAR control-Practical aspects of reactive power problem: Voltage stability, Static & Dynamic VAR requirements, Torsional modes and Sub-synchronous resonance-Sources of reactive power: Capacitor & Reactor, Transformer, Synchronous condenser, Excitation system-Static excitation system, Functionality ,Technical features ,IEEE standards, Generator capability, Under excitation and over excitation limiters-Power system stabilizer (PSS):Function ,Design ,IEEE standard models for PSS-Introduction to Energy Storage (ES) devices: Need for ES, Types & application of ES devices.

**Total: 15 Hours**

**Reference(s)**

1. D. M. Tagare, Reactive Power Management, Tata McGraw Hill Publishing Company Ltd, Fourth Edition 2007.
2. Ter-Gazarian, A.G, Energy Storage for Power Systems, 2nd Edition, IET Publications,2011.

**18EE0XH SUBSTATION DESIGN****0 0 0 1****Course Objectives**

- To understand the operation and basic concepts of substation devices.
- To identify the international standards and codes for substation

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply **technology** to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Examine the components, types and industrial topics of Electrical Substation.
- Construct a single line diagram of distribution panel

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	-	-	-	-	-	-	-	-	-	-	2	1
2	1	1	-	-	-	-	-	-	-	-	-	-	2	1

Introduction to the problem of VAR control-Practical aspects of reactive power problem: Voltage stability, Static & Dynamic VAR requirements, Torsional modes and Sub-synchronous resonance-Sources of reactive power: Capacitor & Reactor, Transformer, Synchronous condenser, Excitation system-Static excitation system, Functionality ,Technical features ,IEEE standards, Generator capability, Under excitation and over excitation limiters-Power system stabilizer (PSS):Function ,Design ,IEEE standard models for PSS- Introduction to Energy Storage (ES) devices: Need for ES, Types & application of ES devices.

**Total: 15 Hours****Reference(s)**

- John D MC Donald, Electric Power Substation Engineering, CRC Press, Taylor & Francis Group,3rd Edition,2012.
- L.G. Hewitson, Mark Brown, Ramesh Balakrishnan, Practical Power System Protection, Newnes,2004.

**18EE0XI DESIGN OF GRID TIED SOLAR PV SYSTEM****1 0 0 1****Course Objectives**

- To understand the fundamentals of Solar PV System.
- To know about the different components of Solar PV System and understand its selection criteria.
- To be able to design practical Solar PV On-Grid Systems.

**Programme Outcomes (POs)**

- a. An ability to apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex Electrical and Electronics engineering problem.
- b. An ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
- c. 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.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Select a suitable Solar PV System Components for grid tied system.
2. Design a practically applicable Solar PV On-grid System.

**Articulation matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	3	-	-	-	-	-	-	-	-	-	2	1
2	1	3	2	-	-	-	-	-	-	-	-	-	2	1

**Contents :**

- Energy and Power Concepts
- Exercises for Household, Industrial and Commercial Load Calculations
- Solar Radiation & Measurements
- Overview of Solar Photo Voltaic System (SPV)
- Types, Sizes and Specifications of Different Components of SPV
- Selection Criteria, Guidelines and Standards for Different Components of SPV
- Factors affecting SPV Module Performance
- System sizing & Design of On-grid SPV Power Plants

**Total:15Hours****Reference(s)**

1. Solanki, C.S., 2013. Solar photovoltaic technology and systems: a manual for technicians, trainers and engineers. PHI Learning Pvt. Ltd.
2. SCGJ, 2016. Solar PV Installer (Suryamitra): Participant Handbook. Unifiers Socialventures Pvt Ltd.

**18EE0XJ DESIGN OF INDOOR AND OUTDOOR LIGHTING USING DIALUX****1 0 0 1****Course Objectives**

- To understand the lighting calculations, types of lamps and its usage in indoor applications.
- To design the illumination system for indoor and outdoor applications using Dialux software .

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
- 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.
- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Analyze the different parameters in illumination system and design of illumination system for various locations.
- Design a lighting system for indoor and outdoor applications using Dialux software

**Articulation matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	-	3	-	-	-	-	-	-	-	-	2	1
2	1	3	-	-	3	-	-	-	-	-	-	-	2	1

**Unit I****7 Hours**

Introduction on Lighting Design and Its Purpose - Brief Introduction on Types of Lamp and Its Usage - Calculation of various factors - Manual Lighting calculation for Indoor Applications (Power Plants, Process Industries, Commercial Building)- Manual Lighting calculation for Outdoor applications (Switchyard, Street Lighting) - Standards on IS, IEC, BS etc.

**Unit II****8 Hours**

Luminaire selection-Overview of Lighting Software - Lighting calculation for Indoor Applications using Lighting software(Power Plants, Process Industries, Commercial Building),Lighting calculation for Outdoor applications using Lighting software (Switchyard, Street Lighting).

**TOTAL: 15 Hours**

**Reference(s)**

1. Joseph B. Murdoch, Illumination Engineering from Edison's Lamp to the Laser, Visions Communications, Washington DC, USA, 1994
2. Jack L. Lindsey, Applied Illumination Engineering, Prentice Hall of India, New Delhi, 2008.
3. Sivanagaraju S, Balasubba Reddy M, Srilatha M, Generation and Utilization of Electrical Energy, Pearson Edition 2010.
4. <https://www.lightnowblog.com/2016/03/introduction-to-lighting-design/>
5. <https://posoco.in/wp-content/uploads/2020/05/Report-on-Pan-India-Lights-Off-Event-9-PM-9-Minutes-on-5th-April-2020.pdf>

**18EE0XK DESIGN OF POWER CONVERTERS FOR INDUSTRIAL APPLICATION**

**1 0 0 1**

**Course Objectives**

- To analyze the conceptual design of converter, inverter for AC motor speed control application.
- To understand and analyze the various types of Sensing circuits.
- To understand the Hardware design for DC Drives.
- To analyze the Solar panel performance for pumping application.
- To understand the PCB design constraints associated in AC and DC Drives.

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Evaluate the performance of converter and its filters design parameters.
2. Evaluate the performance of Inverter design and its gate drivers.
3. Analyze the performance of power supply design using DC-DC converter.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	-	2	-	-	-	-
2	-	-	-	-	-	-	-	-	-	2	-	-	-	-

**Course Content**

Rectifier Design – Inverter design – Selection of switching devices and gate driver – Bootstrap method for High voltage side Gate driver - dc –dc converter design – voltage, current and temperature sensing circuit – speed control techniques for AC and DC drives–PCB design.

**Total : 15 Hours**

**Reference(s)**

1. Muhammad H.Rashid, “Power Electronics Circuits, Devices & Applications” , 4th Edition, Pearson India, 2018.
2. “Control Integrated Power System (CIPOS™) IKCM30F60GD” – Application Note by Infineon.
3. Gustavo Azevedo “Losses and CMV Evaluation in Transformerless Grid-Connected PV Topologies”, IEEE International Symposium on Industrial Electronics (ISIE 2009) Seoul Olympic Parktel, Seoul, Korea July 5-8, 2009.
4. Infineon “2ED020I12-F2 1200 V dual high-side gate driver IC with galvanic isolation, DESAT and short circuit clamping”, Datasheet of Dual IGBT Driver IC.

**18EE0XL LITHIUM BATTERY TECHNOLOGY FOR EV**

**1 0 0 1**

**Course Objectives**

- To understand and analyze the various types of lithium ion batteries
- To analyze the conceptual design of lithium ion batteries for various applications
- To analyze the types of batteries used in electronics and electric vehicles

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Analyze the performance of different types of batteries and how these are different based on different applications.
2. Analyze the performance of lithium ion batteries based on their assembly.
3. Analyze the performance of batteries used in high performance Electric Vehicle.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	-	2	-	-	-	-
2	-	-	-	-	-	-	-	-	-	2	-	-	-	-

**Course Content**

Introduction to Li-ion Battery -Voltage, Current, Watts, Ampere-hour, Watt-hour-Structure of a Li-ion cell, Evolution of the Li-ion cells, Li-ion cell chemistries - Electrical Cell Model- Identifying RC Value of Cell using MATLAB-SOC Estimation using the RC Value -Battery Pack Design: Identifying Number of Cells in Series and Parallel-Battery Aging -Peak Load Optimization - Importance of Mechanical Enclosure- Battery Pack Modelling: Cell Testing Methods and Techniques - Battery pack Modelling -Battery Charging Topologies -Fast Charging.

**Total : 15 Hours**

**Reference(s)**

1. Jiuchun Jiang, Caiping Zhang , “Fundamentals and Applications of Lithium-ion Batteries in Electric Drive Vehicles”, Wiley Publications 2015.
2. Junqiu Li , “Modeling and Simulation of Lithium-ion Power Battery Thermal Management”, Springer Nature Singapore,2022.
3. Thandavarayan Maiyalagan, Perumal Elumalai , “Rechargeable Lithium-Ion Batteries-Trends and Progress in Electric Vehicles”, CRC Press, 2020.
4. Gianfranco Pistoia, “ Lithium-Ion Batteries -Advances and Applications ” ,Elsevier Science,2013.
5. Tariq Muneer, Mohan Kolhe, Aisling Doyle, “Electric Vehicles: Prospects and Challenges”, Elsevier Science, 2017.

## 18EE0XM POWER PLANT AUTOMATION USING SCADA AND DCS

1 0 0 1

### Course Objectives

- To Gain Knowledge on Industrial Automation
- To understand Concept of PLC and Applications
- To understand the Hardware design of Industrial automation Equipment.
- To Gain Knowledge on AC and DC power in automation
- To understand the basics working of Industrial robots.

### Programme Outcomes (POs)

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- k. 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.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

### Course Outcomes (COs)

1. Evaluate the Working of Industrial automation equipment.
2. Analyze the Industrial automation Documents.
3. Analyze the Industrial Standard communication.
4. Apply PLC based wiring concept of panel in industries.

### Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	-	2	-	-	-	-
2	-	-	-	-	-	-	-	-	-	2	-	-	-	-

### Course Content

Introduction to power plant automation – Major players of power automation – Components of power plant automation – Communication protocols — Basics of – DCS – SCADA – Industrial power (AC and DC) – Sensors – Vision systems – Pneumatic's – Industrial control panel and its components - Industrial safety and its equipment – Basic Program example of SCADA .

**Total : 15 Hours**

### Reference(s)

1. Rajput R.K., "A Text book of Power plant Engineering", 5th Edition, Lakshmi Publications, 2013.
2. Vikalp Joshi, Manoj Singh Adhikari, Raju Patel, "Industrial Automation", BPB Publications, 2019.
3. Robert Radvanovsky, Jacob Brodsky "Handbook of SCADA/Control Systems Security", CRC Press, Taylor & Francis Group, 2016.
4. K. Krishnaswamy, M. Ponni Bala, "Power Plant Instrumentation", PHI Learning, 2013.
5. K.L.S. Sharma, "Overview of Industrial Process Automation", Second Edition, Elsevier Science, 2016.

**18EE0XN POWER SYSTEMS DESIGN AND ANALYSIS  
USING ETAP**

**1 0 0 1**

**Course Objectives**

- To acquire knowledge required for planning, operation and control of power system networks through simulation
- To understand the Industrial Power networks.
- To acquire programming skills and experience in the usage of standard packages E-Tap necessary for power system analysis
- To Design and simulate power systems.

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- m.Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n.Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Analyze the real and reactive power voltage of each bus in power systems.
2. Analyze the fault current in the power system network.
3. Selection of transformer and cable rating.
4. Design as suitable starter for electric motors.
5. Assess the stability of the power system during steady and transient operations.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	-	2	-	-	-	-
2	-	-	-	-	-	-	-	-	-	2	-	-	-	-

**Course Content**

Load Flow Analysis With Supporting Hand Calculations-Cable capacity and Sizing-Transformer MVA Sizing-Short Circuit Analysis With Supporting Hand Calculations-Protection & Coordination Analysis-Arc Flash Analysis Using IEEE:1584-2002 Standard-Motor Starting Analysis- Short Circuit Study -Transient Stability Analysis -Harmonic Analysis-Ground Grid Analysis.

**Total : 15 Hours**

**Reference(s)**

1. P.Kundur,Power System Stability and Control, McGraw Hill Publishing Co, New York, 2009.
2. D P Kothari and I J Nagrath,Modern Power System Analysis, Tata McGraw Hill Publishing Co, New Delhi, 2011.
3. Hemchandra Madhusudan Shertukde, “Power Systems Analysis Illustrated with MATLAB and ETAP”, CRC Press, Taylor & Francis Group,2019.
4. Mohammed Alsaq, Power System Harmonic Analysis Using ETAP, Lap Lambert Academic Publishing GmbH KG, 2014.
5. Nasser Tleis,Power Systems Modelling and Fault Analysis, Elsevier Science,2007.

**18GE0XA ETYMOLOGY****1 0 0 1****Course Objectives**

- To increase vocabulary and enhance use, knowledge, and understanding of the English language.
- To stimulate an appreciation for the English language, including how it developed, how new words enter the language, and how it continues to be dynamic.
- To demonstrate the importance of a broad-based vocabulary for effective oral and written communication.

**Programme Outcomes (POs)**

j. 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.

**Course Outcomes (COs)**

1. Examine prefixes, roots, and suffixes of Latin, Greek, Germanic, and Anglo-Saxon origin.
2. Explore the historical aspects of language, including the infusion of Indo-European languages, semantic changes, and the influence of world events.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	-	2	-	-	-	-
2	-	-	-	-	-	-	-	-	-	2	-	-	-	-

**UNIT I****7 Hours****CONVENTIONS**

Acronyms, Abbreviations, Initialises, Jargon Neologisms - Idiomatic Expressions, Euphemisms Spoonerisms Malapropisms ; Mondegreens - Words Derived from Latin - Words Derived from Greek - Words Derived from - Germanic/Anglo-Saxon - Abstract word Acronym - Affix Analogy - Antonym Apherisis - Blend word Assimilation - Colloquial language Clipped word

**UNIT II****8 Hours****WORD ANALYSIS**

Concrete word Derivative - Dialect Diminutive suffix - Dissimilation Doublet - Etymology Euphemism - Figurative word Homonym - Hybrid word Inflection - Informal language Infusion - Jargon Linguistics - Loan words Metathesis ; Modify - Philology Onomatopoeia - Romance language Prefix - Semantics - Root-base word - Suffix Slang - Word component Synonym

**Total: 15 Hours****Reference(s)**

1. Norman, Lewis. Word Power Made Easy, Goyal Publisher. Edition 2. 2014.
2. C T Onions. The Oxford Dictionary of English Etymology, Volume 11, Issue 1.70, Wynford Drive, Don Mills, Ont, Oxford University Press.1965.
3. Nurnberg W, Maxwell and Rosenblum, Morris, How to build a better Vocabulary, Completely Revised and Updated, Popular Library. 1961.

**18GE0XB GENERAL PSYCHOLOGY****1 0 0 1****Course Objectives**

- To provide a basic understanding of psychology.
- Defining Psychology and the subject matter of psychology.
- To provide an awareness of various methods and branches of psychology.
- To explain social and work psychology of people and the need for mental health.

**Programme Outcomes (POs)**

- h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**Course Outcomes (COs)**

1. Understand the basics of human behavior in the workplace and society at large.
2. Understand the different fields of psychology and its uses.
3. Deal people effectively in their personal and social life.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	2	1	-	-	-	-	-
2	-	-	-	-	-	-	-	2	2	-	-	-	-	-
3	-	-	-	-	-	-	-	2	3	-	-	-	-	-

**UNIT I****15 Hours****GENERAL PSYCHOLOGY**

Psychology - Introduction - Mind body relationship - Methods and Scope of Psychology -Motivation-Types of Needs- Motivational Cycle- Intelligence: Concept of Intelligence and IQ- measurement - Social psychology: individual behavior and group behavior - Group dynamics- group formation- social influence-social cognition, stereotypes- prejudice- discrimination - Definitions, formation of attitude, factors of attitude formation-change of attitude.

**Total: 15 Hours****Reference(s)**

1. Atkinson & Atkinson, Introduction to Psychology, 6th Ed McGraw-Hill Publications. 1975
2. Mishra, B. K, Psychology: The study of human behavior, 2nd Ed New Delhi: Prentice Hall of India Learning Pvt. Ltd. 2016.
3. Baron, R.A., Branscombe. N.R, Social Psychology, 14th Ed. New Delhi; Pearson Education. 2016
4. Morgan, C.T., King, R.A., Weisz, J.R., & Schopler, J. Introduction to Psychology, 7th Ed. New Delhi: Tata McGraw Hill. 1993.

**18GE0XC NEURO BEHAVIORAL SCIENCE****1 0 0 1****Course Objectives**

- To provide an introduction to the Cognitive Neuro Science of languages.
- To provide an understanding of the Cognitive processes.

**Programme Outcomes (POs)**

- Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**Course Outcomes (COs)**

1. Identify the psychological problems that will impact mental health.
2. Value ethical conduct in professional and personal life.
3. Recognize the need for rationale and evidence in decision-making.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	1	-	-	-	-	-
2	-	-	-	-	-	-	-	-	2	-	-	-	-	-
3	-	-	-	-	-	-	-	-	3	-	-	-	-	-

**UNIT I****15 Hours****NEURO BEHAVIOURAL SCIENCE**

Introduction to physiology - Anatomy - Neuro Biology - Psycho Neuro Science Behaviour and Hormones  
- Behaviour Modifications - Relaxation Therapy - Psycho Education for minds

**Total: 15 Hours****Reference(s)**

1. Beck, Robert. Handbook of Physiology. Vol I. Oxford University Press March 15,1996
2. Horon C Philip. Sexology and Mind. Academic Press. 1993
3. Blatteis M.Clark and Melvin J. Fregly. Handbook of Physiology Sect 4, Oxford University Press. March 15, 1996.

**18GE0XD VISUAL MEDIA AND FILM MAKING****1 0 0 1****Course Objectives**

- To acquire fundamental knowledge on development of filmmaking as an art
- To provide students a basic understanding of the techniques and nuances of visual medium
- To inculcate an ability to plan and produce a short film

**Programme Outcomes (POs)**

f. 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.

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

**Course Outcomes (COs)**

1. Understand the significance and techniques of visual medium
2. Analyse and produce visual clippings

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	2	2	-	-	-	-	-	-	-
2	-	-	-	-	-	2	2	-	-	-	-	-	-	-

**UNIT I****15 Hours****ART OF FILMMAKING**

History of Cinema (Origin and Narrative) Cinema as a visual medium -Significance of Editing Styles of Editing Editing as a methodology (Hollywood s Invisible Editing) Technical Aspects of Editing (Final Cut Pro (FCP), AVID and Premire Pro) - Basics of video production (pre-production to post-production) Different types of shots and angles - Film style and Narrative (Italian Neo-realism, Avant Garde, Russian Formalism, Alternative Cinema etc.,) Regional Cinema to National Cinema Basics of Script Writing (Double and Single Column) Basics of Video Production (script to screen) Final submission of a script for five minutes short film

**Total: 15 Hours****Reference(s)**

1. Monaco, James, How to Read a Film: Movies, Media, and Beyond. Auckland: OUP, 2009.
2. Belavadi, Vasuki, Video Production. India: OUP, 2013.

**Course Objectives**

- To know about the history and schools of yoga
- To know the difference between supreme consciousness and individual consciousness
- To apply the knowledge by the way of practice and introspection

**Programme Outcomes (POs)**

h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**Course Outcomes (COs)**

1. Understand the historical aspects and schools of yoga
2. Ensure their physical & mental wellness through yoga practice
3. Develop the power to concentrate and have stress free mind.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	2	2	-	-	-	-	-
2	-	-	-	-	-	-	-	2	2	-	-	-	-	-
3	-	-	-	-	-	-	-	2	2	-	-	-	-	-

**UNIT I**

**15 Hours**

**YOGA FOR HUMAN EXCELLENCE**

What is Yoga , History of Yoga - Yoga in today's scenario- Schools of Yoga - Eight Limbs of Yoga - Sathvic, Rajasic, Tamasic Foods and Thoughts - Science of Yoga Loosening Exercises - Yogasanas & Benefits - Super Brain Yoga - Surya Namaskar Standing Asanas - Sitting Asanas - Prone Asanas - Supine Asanas - MudrasRelaxation - Pranayama - Meditation

**Total: 15 Hours**

**Reference(s)**

1. Vethathiri Publications, Yoga Practices-2, Erode, 2012.
2. Iyengar B.K.S. Yoga: Wisdom & Practice, B.K.S. Iyengar, 2009.
3. Ramesh Partani, The Complete Secret, Ru Education, 2013.
4. <http://www.sarvyoga.com/>
5. <http://www.wikihow.com/Do-Superbrain-Yoga>

**18GE0XF VEDIC MATHEMATICS****1 0 0 1****Course Objectives**

- To improve their calculation speed, analytical thinking and numerical skills

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

- Solve problems creatively in mathematics and its applications

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	-	-	-	-	-	-	-	-	-	-	-	-

**UNIT I****15 Hours****VEDIC MATHEMATICS**

Addition- Subtraction- System of Multiplication- Squaring numbers- Cube roots- Square roots- Solution of simultaneous equations- Solutions of Quadratic equations

**Total: 15 Hours****Reference(s)**

- Dhaval Bathia, Vedic Mathematics, JAICO Publishing House, 29th Edition, Mumbai, 2014
- Jagadguru Swami Sri Bharathi Krsna Tirthaji Maharaja, Vedic Mathematics, Motilal Banarsidass Publishers Private Limited, New Delhi, 1997.

**18GE0XG HEALTH AND FITNESS****1 0 0 1****Course Objectives**

- To understand the fundamental concepts about physical fitness & its types, training and assessment of physical fitness

**Programme Outcomes (POs)**

- f. 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.
- g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**Course Outcomes (COs)**

- Acquire the knowledge and training of the individual physical, mental and social concepts
- Understand the fundamental concepts of yogic practice and physical fitness
- To acquire the knowledge about nutrition and health consciousness

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	1	-	2	-	-	-	-	-
2	-	-	-	-	-	2	-	-	2	-	-	-	-	-
3	-	-	-	-	-	2	-	-	2	-	-	-	-	-

**UNIT I****5 Hours****FITNESS**

Meaning & Definition, Need & importance of Physical fitness, Types Physical fitness - Exercise, Training and Conditioning and it is important

**UNIT II****5 Hours****YOGA AND MEDITATION**

Meaning and definition; Principles of practicing; Basic Asana and it important; Pranayama and Meditation - Relaxation Techniques

**UNIT III****5 Hours****NUTRITION AND BALANCE DIET**

Nutrition and Balance Diet: Needs and Important, Significant of Nutritional Food - Tips for balance diet. Common Diseases for IT professionals: Common diseases - cause prevention-First aid for common sports injuries.

**Total: 15 Hours**

**Reference(s)**

1. Anderson, Bob., Pearl, Bill.,&Burke, Edmund R., (2001). Getting in Shape Workout Programs for Men&Women. Mumbai: Jaico Publishing House
2. Baechle, Thomas. R, & Earle, Roger. W., (2000). Essentials of Strength Training and Conditioning. Champaign: Human Kinetics
3. Iyengar, BKS., (2003). The Art of Yoga. New Delhi: Harper Collins Publishers
4. Singh, Hardayal, (1995). Science of Sports training. New Delhi: D.V.S. Publications
5. Begum, Raheena. M., (2002). A Textbook of Foods, Nutrition and Dietetics. New Delhi: Sterling Publishers Private Limited.

## 18GE0XH CONCEPT, METHODOLOGY AND APPLICATIONS OF VERMICOMPOSTING

1 0 0 1

### Course Objectives

- To understand the importance of safe methods of treating solid wastes generated through various human activities
- To appreciate the skills / devices / practices associated with the compact procedures of biodegradation of unwanted solid residues

### Programme Outcomes (POs)

f. 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.

### Course Outcomes (COs)

1. Understand the role of recycling of garbage leading to the sustenance of our health and environment.
2. Recognize the organic farming practices and production of healthy food products.
3. Prepare and maintain tips for small scale compost units and thereby becoming more environmentally conscious

### Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	2	-	-	-	-	-	-	-	-
2	-	-	-	-	-	2	-	-	-	-	-	-	-	-
3	-	-	-	-	-	2	-	-	-	-	-	-	-	-

### VERMICOMPOSTING TECHNOLOGY

Ecological roles and economic importance of earthworms - need for earthworm culture, scope and importance of vermiculture , limiting factors - types of worm culturing and the relative benefits Small scale and commercial methods: process & advantages , Vermicomposting equipments, devices, Design and maintenance of vermi bed - Products from vermiculture (matter & humus cycle), vermicastings in organic farming/horticulture - Marketing the products of vermiculture quality control, market research, marketing techniques , Applied vermiculture: use of urban solids & farm/ industrial residues for vermicomposting - Constraints of vermiculture and its future perspectives Artificial Earthworm as a standalone biodegradation assembly.

**Total: 15 Hours**

### Reference(s)

1. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.4
2. Vermiculture Technology; Earthworms, Organic Wastes and Environmental Management, 2011, Edited by Clive A Edwards, Norman Q Arancon & Rhonda Sherman, CRC Press
3. [www.organicgrowingwithworms.com.au](http://www.organicgrowingwithworms.com.au)
4. New York Times , Scientists Hope to Cultivate and Immune System for Crops.

**18GE0XI BLOG WRITING**

**1 0 0 1**

**Course Objectives**

- To sharpen and improve writing skills, including draft writing, voice, and format.
- To develop general and global knowledge.
- To experiment with non-written forms of online communications, including images, audio and video.
- To be able to add content to your website without the assistance of a web designer.

**Programme Outcomes (POs)**

- f. 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.
- g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- j. 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.

**Course Outcomes (COs)**

1. Understand the flow of language in natural manner.
2. Understand the elements of a blog and be able to use them effectively.
3. Find a niche for a long-term blog.
4. Gain insight into the strategies, methods and writing of successful bloggers.
5. Develop their creative thinking.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	-	-	-	1	-	-	-	-
2	-	-	-	-	-	-	-	-	-	1	-	-	-	-
3	-	-	-	-	-	2	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	2	-	-	-	-	-	-	-
5	-	-	-	-	-	-	2	-	-	-	-	-	-	-

**UNIT II**

**8 Hours**

Voice: Defining and achieving voice. Exploring various voices. Stylistic tips—rhythm, verbs, interesting words, senses, emphasis. Smartness and sarcasm. Reliability - accuracy, provability, specificity. Transparency about payments. Sample Blogs and Activities

**Total: 15 Hours**

**Reference(s)**

1. The Elements of Blogging: Expanding the Conversation of Journalism, by Mark Leccese and Jerry Lanson. (Taylor & Francis, 2015) ISBN: 978-1-13-802154-9. \$29.95 paperback.
2. Blogging Heroes, by Michael Banks. Choose 15 of the 30 interviews/profile segments to read, be sure to include the segments on Chris Anderson and Brian Lam.
3. Complete Guide to Blogging, Huffington Post.

**18GE0XJ INTERPERSONAL SKILLS****1 0 0 1****Course Objectives**

- To communicate and work effectively, both individually and in groups
- To be able to understand and manage ones own and others emotions
- To define and solve problems by making decisions about the best course of action

**Programme Outcomes (POs)**

- g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**Course Outcomes (COs)**

1. Express themselves clearly and confidently
2. Listen to others completely and with empathy
3. Assert an opinion without diminishing others opinion
4. Be responsible and timely with a willingness to collaborate
5. Develop innate personality traits to handle certain social situations

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	2	-	2	-	-	-	-	-
2	-	-	-	-	-	-	2	-	2	-	-	-	-	-
3	-	-	-	-	-	-	2	-	2	-	-	-	-	-
4	-	-	-	-	-	-	2	-	2	-	-	-	-	-
5	-	-	-	-	-	-	2	-	2	-	-	-	-	-

**UNIT I****7 Hours****INTRODUCTION**

Conversational Skills - Active Listening - Team working Empathy - Emotional Intelligence

**UNIT II****8 Hours****SKILLS**

Conflict Resolution and Mediation skills - Decision making and Problem Solving - Negotiation and Persuasion skills

**Total: 15 Hours****Reference(s)**

1. Stephen P. Robbins, Phillip L. Hunsaker, Training in Interpersonal Skills, Pearson, 2015
2. Robert B. Cialdini, Influence: The Psychology of Persuasion, Harper Business; Revised Edition, 2006
3. Suzanne C De Janasz, Karen O Dowo & Beth Z Schneder, Interpersonal Skills in Organisations, McGraw-Hill Education; 5th Edition, 2014.

## 18GE0XK COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT

1 0 0 1

### Course Objectives

- Understand the role of National Service Scheme in community
- Identify the needs and problems of the community and involve in problem solving
- Develop competence required for group living and acquire leadership qualities

### Programme Outcomes (POs)

- g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- ii. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

### Course Outcomes (COs)

1. understand the community in which they work and render their service
2. develop among themselves a sense of social and civic responsibility

### Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	2	-	2	-	-	-	-	-
2	-	-	-	-	-	-	1	-	2	-	-	-	-	-

### UNIT I

15 Hours

#### COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT

Introduction and Basic Concepts of NSS: History-philosophy-aims & objectives of NSS- Emblem, flag, motto, song, badge- Organizational structure roles and responsibilities functionaries. NSS Programmes and Activities: Concept of regular activities, special camping, DayCamps-Basis of adoption of village/slums-Methodology of conducting Survey -Financial pattern of the scheme -Coordination with different agencies-Maintenance of the Diary. Community Mobilization: Mapping of community stakeholders-Designing the message in the context of the problem and the culture of the community- Identifying methods of mobilization-Youth-adult partnership. Health, Hygiene & Sanitation: Definition, needs and scope of health education- Food and Nutrition - Safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan). Entrepreneurship Development: Definition & Meaning - Qualities of good entrepreneur - Steps/ways in opening an enterprise -Role of financial and support service Institutions.

**Total: 15 Hours**

**Reference(s)**

1. A Hand book on National Service Scheme, Anna University, Chennai, 2012
2. <http://nss.nic.in/intro.asp>
3. Delgado-Gaitn and Concha, The Power of Community: Mobilizing for Family and Schooling New York: Rowman & Littlefield Publishing, Inc. 2001
4. James Bailey, Guide to Hygiene and Sanitation in Aviation, World health organization, 2nd edition. 1980
5. Anuradha Basu, Mark Casson, Nigel wadeson and Bernard Yeung, The oxford hand book of entrepreneurship, Oxford Press. 2009.

**18GE0XL NATIONAL CADET CORPS****1 0 0 1****Course Objectives**

- To understand the importance of NCC and its organization.
- To realize the skills in the applications of drill and weapon training.
- To analyze the factors in National unity
- To identify the utility of smart materials in engineering applications.

**Programme Outcomes (POs)**

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

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**Course Outcomes (COs)**

1. Recall the motto and aim of NCC.
2. Implement synergy in disaster management.
3. Execute an example patriotic leader to serve nation

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	2	-	2	-	-	-	-	-
2	-	-	-	-	-	-	1	-	2	-	-	-	-	-
3	-	-	-	-	-	-	1	-	2	-	-	-	-	-

**UNIT I****12 Hours****NCC STRUCTURE AND TRAINING**

NCC

ORGANIZATION

National Cadet Corps: Aim and Objectives - Administrative and Organizational pattern - NCC flag and NCC song - Duties, Responsibilities and Conduct by NCC Cadets - Badges of ranks in NCC and Armed forces- Types of NCC camps - Eligibility conditions for writing B and C certificate examinations. Cadet welfare society and Career opportunities for NCC cadets.

DRILL

AND

WEAPON

TRAINING

Drill: Aims of drill - Types of drill - Foot drill, Arms drill and Ceremonial drill. Word of commands, Guard of honour. Weapon training - Rifles used in NCC: Parts and Characteristics of 0.22 and INSAS - Stripping, Assembling and Cleaning of weapons.

NATIONAL

INTEGRATION

AND

SOCIAL

AWARENESS

National Integration: Introduction - Constitution of India- Importance and Necessity - Factors affecting National integration - Role of NCC in National integration. Social service and its need - Rural development programs - NGOs role and Contribution - Social Security schemes.

**UNIT II**

**8 Hours**

**PERSONALITY DEVELOPMENT AND LEADERSHIP**

**PERSONALITY DEVELOPMENT AND LEADERSHIP**

Personality Development: Introduction - Factor influences in personality development. Leadership: Leadership traits and Skills - Indicator of good leader - Honour code concept - Type of leaders - Case studies of effective leader.

**DISASTER MANAGEMENT AND FIRST AID**

Disaster types - Natural and Manmade disasters. Role of NCC cadets in disaster management. Civil defence: Civil defence measures - Civil defence services. First aid: First aid kits and Equipments - First aid for snake bite, Sun stroke and Drowning - Respiration -Types of respiration.

**Total: 20 Hours**

**Reference(s)**

1. Cadets Hand book Common subject, DG NCC, New Delhi.
2. Cadets Hand book Special subject, DG NCC, New Delhi
3. Misra R.C and Sanjaykumar Mishra, A HAND BOOK OF NCC(English), Kanti Prakashan, 2016
4. Gupta R. K, NCC: Handbook of NCC Cadets for A, B and C Certificate Examinations (English) RPH Editorial Board, 2018.

## 18GE0XM NEW AGE INNOVATION AND ENTREPRENEURSHIP

1 0 0 1

### Course Objectives

- To make the participants understand as to how to get along with the task of setting independent business units and on the various facets of running a business
- To get the budding young entrepreneurs to appreciate the structured knowledge of the dynamics of operationalizing a business opportunity

### Programme Outcomes (POs)

- b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- f. 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.
- i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

### Course Outcomes (COs)

1. Understanding entrepreneurship as an important career option
2. Concept and methodology of idea translation to viable start-ups
3. Events to occur in the building of a technology based venture for students or working professionals or women
4. Overview of Indian trends in the start-up scene

### Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	2	-	-	2	-	-	-	-	-
2	-	-	-	-	-	2	-	-	2	-	-	-	-	-
3	-	-	-	-	-	2	-	-	2	-	-	-	-	-
4	-	-	-	-	-	2	-	-	2	-	-	-	-	-

### UNIT I

15 Hours

#### NEW AGE INNOVATION AND ENTREPRENEURSHIP

Introduction to Entrepreneurship - Opportunity Identification ideation -MVPPositioning as an Entrepreneur Starting own Business - Developing Effective Business Model - Industry and Competitor Analysis - Building Business PlanMentoring Session with Investors- Legal and Ethical Foundation for Startup. Types of startups and licensing systems - MSME -Evaluating the Financial Strength of a New Venture/Project - Getting Funding - Types of Sources VCs, Angel funding, PE etc. -Marketing Strategies for New Ventures - IT Systems - IPR - Strategies for New Venture Growth - Talent Acquisition and Management for New Ventures - Valuation Challenge in Entrepreneurship - Intrapreneurship Sustainability - Exit strategies and Start-up trends in India.

**Total: 15 Hours**

**Reference(s)**

1. Kathleen R. Allen, Launching New Ventures, South-WesternCengage Learning, 6th Edition, 2012
2. Alex Osterwalder and Yves Pigneur, Business Model Generation, publishedby the authors, 2010
3. Branson. R. Business stripped bare, New York, Penguin books, 2011
4. Moris MH, Kuratko DF and Covin JG, Corporate entrepreneurship and innovation, 3 edition, Mason, Oh; CENGAGE/SOUTH WESTERN publisher, 2011

## 18GE0XN DISRUPTIVE INNOVATION BASED STARTUP ACTIVITIES

1001

### Course Objectives

- To make the participants understand as to how to get along with the task disruption led innovations.
- To get the budding young entrepreneurs to appreciate the structured knowledge of the dynamics of operationalizing creativity based disruption strategy

### Programme Outcomes (POs)

- g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

### Course Outcomes (COs)

1. Understanding contemporary entrepreneurship as an important career option
2. Concept and methodology of creative disruption to viable start-ups
3. Events to occur in the building of a technology based venture for students or working professionals or women with disruptive technology option
4. Overview of Indian trends with reference to disruptive innovation based start-ups

### Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	-	2	2	-	-	-	-	-	-
2	-	-	-	-	-	-	2	2	-	-	-	-	-	-
3	-	-	-	-	-	-	2	2	-	-	-	-	-	-
4	-	-	-	-	-	-	2	2	-	-	-	-	-	-

### UNIT I

15 Hours

#### DISRUPTIVE INNOVATION

Creativity linked innovation- Differences between Disruptive & incremental Innovations - Historical, theoretical, and practical evolution of disruptive innovation (DI). - Idea generation & communication of creativity leading to DI. Innovation management concepts in DI based entrepreneur generation - How do firms bring in new business models and get new products and services to the market? Investor preferences in core versus new or disruptive business models - disruptors and the disrupted frameworks for assessing company's capabilities and rethinking product, market and strategy - Right customers for DI: strategy in a world that is changing so rapidly -Application of disruptive theories to complex problems and opportunities.

**Total: 15 Hours**

#### Reference(s)

1. <https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1540-5885.2005.00177.x>
2. <http://www.brinq.com/workshop/archives/2005/01/08/what-is-disruptive-innovation>
3. <https://hbr.org/2006/12/disruptive-innovation-for-social-change>

4.

**18GE0XO SOCIAL PSYCHOLOGY****1 0 0 1****Course Objectives**

- To provide a basic understanding of social psychology.
- Defining psychological & physical changes during puberty age.
- To provide an awareness of various psychological problems and social problems.
- To explain social and work psychology of people and the need for mental health.

**Programme Outcomes (POs)**

f. 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.

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

i. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**Course Outcomes (COs)**

1. Understand the basics of human behavior in the workplace and society at large
2. Understand the various psychological, physical, social problems and management skills.
3. Deal people effectively in their personal and social life.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	2	2	-	1	-	-	-	-	-
2	-	-	-	-	-	1	2	-	1	-	-	-	-	-
3	-	-	-	-	-	2	2	-	3	-	-	-	-	-

**UNIT I**

**7 Hours**

**INTRODUCTION**

Introduction - Ice breaker - Time Line - Tasks and Challenges of the age( Erik Erikson)Physical changes - Introduction to Reproductive Health - Reproductive Organs - Menstruation - Changes during Puberty - Abortions - Contraception - Difference between Sex and Gender - Introduction to the origins of Patriarchy - Gender.

**UNIT II**

**8 Hours**

**PSYCHOLOGY**

Developmental changes - Attraction - Friendship - Differences and Similarities - Images of Beauty and Body Image -Introduction to Media-Feedback - Sexuality - Boundaries Relationships - Marriage - Love - Emotional Health - Sexual Abuse and Safety - Role of Media - Abortions, Contraception, Wrapping up the Course.

**Total: 15 Hours**

**Reference(s)**

1. Baron, R. A.,Branscombe.N.R.(2016).Social Psychology,14th Ed. New Delhi;Pearson Education
2. Morgan,C.T., King,R.A.,Weisz,J.R.,&Schopler,J.(1993). Introduction to Psychology,7th Ed.New Dehi:Tata McGraw Hill.

## 18GE0XP FM RADIO BROADCASTING TECHNOLOGY

1 0 0 1

### Course Objectives

- The course focuses on community radio technology and various program productions techniques for FM Radio Broadcasting.

### Programme Outcomes (POs)

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.

### Course Outcomes (COs)

- Understand the hardware required for field recording and setting up a studio and carry out studio and field recording.
- Examine the available options for telephony interfaces for radio.
- Demonstrate proper techniques of wiring, fixing of connectors, soldering and use of tools and equipment for studio work.

### Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	3	2	-	-	-	-	-	-	-	-	-	-	-
2	2	2	2	-	-	-	-	-	-	-	-	-	-	-
3	2	2	2	-	-	-	-	-	-	-	-	-	-	-

### UNIT I

3 Hours

#### INTRODUCTION TO AM/ FM RADIO

History of Radio-Types of Radio and its Reach- Entertainment Radio- Community Radio- Internet Radio- Satellite Radio. Evolution of Community Radio (CR) in India- principles behind setting up of FM/CR- policy guidelines and their impact on technology and content of a CR station- fundamental principles behind deciding the technology for a CR station.

### UNIT II

3 Hours

#### STUDIO TECHNOLOGY

Use of Microphones-Console handling-OB Recordings & Live Shows-Properties and components of sound-difference between analogue and digital audio-hardware required for field recording and setting up a studio-fundamental principles for setting up an audio studio.

**UNIT III**

**3 Hours**

**AUDIO PRODUCTION**

Concept of recording and storing audio-hardware related to audio recording-open source software solutions for audio production-telephony interfaces for radio- audio Post Production. Voice Culture Exercise- Radio Production Techniques & Tools.

**UNIT IV**

**3 Hours**

**STUDIO OPERATIONS**

Wiring, fixing of connectors, soldering and use of tools and equipment- preventive and corrective maintenance of studio and equipment.

**UNIT V**

**3 Hours**

**RADIO TRANSMISSION TECHNOLOGY**

Components of the FM transmission chain- FM transmitter-different types of FM antenna - coaxial cable-propagation and coverage of RF signals-FM transmitter setup- Radio audience -measurements systems.

**Total: 15 Hours**

**Reference(s)**

1. UNESCO (2001). Community Radio Handbook.
2. Vinod Pavarala, Kanchan K Malik, Other Voices: The Struggle for Community Radio in India, SAGE Publications India, 2007.
3. Steve Buckley, Mark Raboy, Toby Mendel, Kreszentia Duer, Monroe E. Price, Sean O Siochru, Broadcasting, Voice, and Accountability: A Public Interest Approach to Policy, Law, and Regulation, University of Michigan Press, 2008.
4. [www.floridasound.com](http://www.floridasound.com)
5. [www.mediacollege.com](http://www.mediacollege.com)
6. [www.mediacollege.com](http://www.mediacollege.com)

**18EEV01 ORCAD**

**Course Objectives**

- To apply the concepts of simulation tool to design and develop various converter topologies and customize engineering user interfaces for industrial system design using ORCAD.

**Programme Outcomes (POs)**

- An ability to apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex Electrical and Electronics engineering problem.
- An ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- To develop a model of Electronic appliances using ORCAD software in the area of Electronics and Embedded systems.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	-	2	-	-	-	-	-	-	-	1	1

**UNIT I  
ORCAD**

Introduction about Orcad software-Scope of PCB Designing-Market & Job Prospects of PCB Designing-Software Description about Orcad software-Introduction on Design circuit of Orcad PCB software-ARES(Proteus-7 Professional)-Examples based basic electronics circuit Schematic creation-Understanding schematics and symbols-Searching components footprints and symbols-Choosing the right components-Schematic Layout of Half wave rectifier-Editing symbol libraries-Board creation-Manual routing-Go through the Schematic Layout of Half wave rectifier-Component-placing-Practice via manual routing and auto routing on PCB-Design verification-3D image output verification-Go through the Schematic Layout of Full wave rectifier-Component-placing-Practice via manual routing and auto routing on PCB-Design verification-3D image output verification-Go through the Schematic Layout of Bridge rectifier-

Component-placing-Practice via manual routing and auto routing on PCB-Design verification- 3D image output verification-Exercise & practice on SchematicLayout of ac to dc (7805) power supply-Component mounting-Practice via all routing techniques on PCB-3D image output verification-Exercise & practice on SchematicLayout of ac to dc (7812) power supply- Component mounting-Practice via all routing techniques on PCB-3D image output verification- Exercise & practice on SchematicLayout of ac to dc (7805 &7812) power supply with one board-Component mounting-Practice via all routing techniques on PCB-3D image output verification- Continuity test and proper installation-output analysis.

**TOTAL : 30 Hours**

**Reference(s)**

1. PSpice Simulation of Power Electronics Circuits: An Introductory Guide by E. Ramshaw, D.C. Schuurman
2. SPICE for Power Electronics and Electric Power by Muhammad H. Rashid.
3. <https://www.orcad.com/resources/library>
4. [https://www.seas.upenn.edu/~jan/spice/PSpice\\_ReferenceguideOrCAD.pdf](https://www.seas.upenn.edu/~jan/spice/PSpice_ReferenceguideOrCAD.pdf)
5. [https://www.ecadtools.com.au/documents/PSpice%2017.2%20Advanced%20Analysis%20User%20Guide%20\(pspaugca\).pdf](https://www.ecadtools.com.au/documents/PSpice%2017.2%20Advanced%20Analysis%20User%20Guide%20(pspaugca).pdf)

## 18EEV02 HANDS ON TRAINING ON DESIGN OF CONTROLLERS OF POWER CONVERTER

### Course Objectives

- To apply the concepts of Power Converters to develop and design converter topologies and customize engineering user interfaces for industrial system design using TI WEBENCH online simulation tool

### Programme Outcomes (POs)

- An ability to apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex Electrical and Electronics engineering problem.
- An ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
- Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- Design, **analyze**, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems

### Course Outcomes (COs)

- Apply the power converter design for industrial and controller applications

### Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	-	2	-	-	-	-	-	-	-	1	-

Introduction to Power Converters – Types, Power converters for renewable energy and industrial applications, design of controllers for different power converter topologies using WEBENCH TI-Simulation tool, Optimized design for foot print and efficiency, generate schematic and electrical analysis, generate layout and thermal analysis, Preparation of Bill of Materials (BOM) and Project reports

**TOTAL : 30 Hours**

### Reference(s)

- <http://www.ti.com/design-resources/design-tools-simulation/webench-power-designer.html>
- <https://webench.ti.com/power-designer/switching-regulator/select>

## 18EEV03 IOT BASED SYSTEM DESIGN

### Course Objectives

- To Understand the IoT concept and its impact
- To recognize various tools and platforms for implementing IoT.
- To Learn how to use Hardware's to perform varying and complex tasks.
- To understand advanced and emerging technologies.
- Develop skills to design and develop applications in different aspects.

### Programme Outcomes (POs)

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- d. 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.
- e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society

### Course Outcomes (COs)

1. Explain the building blocks of Internet of Things and characteristics.
2. Assess the IoT architecture and protocols for designing an IoT environment.
3. Use the hardware and software platforms for IoT and develop an IoT product.
4. Analyze the role and implementation of microcontrollers in IoT.
5. Apply the state of art IoT based systems, suitable for real life and Industry applications.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	2	-	2	-	-	-	-	-	-	-	2	-
2	2	2	3	2	2	-	-	-	-	-	-	-	3	-
3	2		3	2	2	-	-	-	-	-	-	-	2	1
4	2	2	3	2	-	-	-	-	-	-	-	-	1	2
5	2	2	3	-	2	-	-	-	-	-	-	-	2	-

**UNIT I****6 Hours****INTRODUCTION TO IOT**

Evolution of Internet of Things – Enabling Technologies – IoT Architectures, Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects - IoT Challenges and Issues

**Activity:** Identifying problem statement – Customer and Market Survey – Product Design approach

**UNIT II****6 Hours****IOT ARCHITECTURE AND COMPONENTS IN INTERNET OF THINGS**

IoT Architecture: Node, Gateway, Network infrastructure and Cloud server – Components of IoT: Control Unit, Communication modules Bluetooth Zigbee Wifi GPS- IoT Protocols (IPv6, 6LoWPAN, RPL, CoAP), MQTT, Wired Communication

**Activity:** IoT Product Vision and Mission – Identifying target customer for an IoT product – Leancanvas

**UNIT III****6 Hours****IOT DEVELOPMENT HARDWARES AND TECHNOLOGIES BEHIND IOT**

IoT Hardware Considerations – IoT programming Considerations – Open source hardware platforms, designing of Proprietary Hardware – IoT Cloud services – Four pillars of IoT paradigm, RFID, Wireless Sensor Networks, SCADA (Supervisory Control and Data Acquisition), M2M - IOT Enabling Technologies - Embedded Systems

**Activity:** Developing working model of IoT product

**UNIT IV****6 Hours****PROGRAMMING THE MICROCONTROLLER FOR IOT**

Working principles of sensors IoT deployment for Raspberry Pi /Arduino /Equivalent platform Reading from Sensors, Communication: Connecting microcontroller with mobile devices, communication through Bluetooth, wifi and USB

**Activity:** Demonstration of IoT product – Results and discussion

**UNIT V****6 Hours****IOT APPLICATIONS**

Smart Farming: Weather monitoring, precision farming, Smart Greenhouse, Drones for pesticides, Energy Consumption Monitoring, Smart Energy Meters, Home automation, Smart Grid and Solar Energy Harvesting, Intelligent Parking

**Total:30 Hours**

**Reference(s)**

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, 1st Edition, Academic Press, 2014.
2. Cuno Pfister, "Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud (Make: Projects)", Maker Media, 1st edition 2011
3. Vijay Madisetti and Arshdeep Bahga, Internet of Things (A Hands-on-Approach), 1st Edition, VPT, 2014.
4. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things Key applications and Protocols, Wiley, 2012.
5. Designing the Internet of Things (Nov 2013) by Adrian McEwen & Hakim Cassimally.

**18EEV04 ELECTRONIC CIRCUIT DESIGN****Course Objectives**

- To understand the basic concepts and design in electronic circuits
- To design and analyze the circuits in Proteus and MULTISIM software
- To design the Printed Circuit Board for electronic circuits

**Program Outcomes(POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems

**Course Outcomes(COs)**

1. Understand the basic electronic principles and simulate the circuits to build Printed Circuit Board using PROTEUS software
2. Build a schematic and evaluate circuit performance through interactive simulation using MULTISIM software

**3. Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	-	-	-	3	-	-	-	-	-	-	-	3	-
2	2	-	-	-	3	-	-	-	-	-	-	-	3	-

**UNIT I****Electronics and Proteus****15 Hours**

Introduction to Electronic Components and Proteus Software - Basic Electrical Measuring Instruments (Analog & Digital) - Passive Components - Switches - Active Components - Semiconductor Diode - Zener diode - Power Supply (Converters) - Un Regulated Power Supply - Regulated Power Supply - Transistors - PNP Transistor & NPN Transistor - MOSFET - Industrial/Power Electronics - UJT - TRIAC - Circuit Ideas / Projects/R & D Technique - Communication Circuits - Timer Circuit - AC To DC Interfacing Circuits - Sensing Circuits Interconnection Techniques - SMD Technique - PCB Designing by Using Proteus Software

## UNIT II

### Multisim

10 Hours

Introduction to MULTISIM: Toolbars and Components - Basic circuit laws simulation: Ohm's law, Kirchoff's laws, Voltage division, Current division - Diode circuits simulation: V-I characteristics of diode, Rectifier, clipper and clamper - Operational Amplifier circuits simulation: Introduction, Inverting Op-amp, Non-Inverting Op-amp, Differential Op-amp and Summing Op-amp - Digital logic circuits

Simulation: Logic gates and verification, Logic converter- Adders and subtractors - Multiplexers - Seven segment display- flip flops - 60 seconds stopwatch circuit.

### Macro and Mini Projects

5 Hours

**Total:30 Hours**

### References:

1. Lambert M. Surhone, Miriam T. Timpledon, Susan F. Marseken, "PROTEUS (Design Software), VDM Publishing, 14-Jul-2010.
2. David Baez-Lopez, Felix Guerrero-Castro, "Circuit Analysis with Multisim", 2011.
3. Marc E. Herniter,"Schematic Capture with Multisim 7", 2004.
4. John Hackworth , "Digital Circuit Analysis with Multisim", 2018.
5. James W. Nilsson, Susan Riedel , "Introduction to Multisim for Electric Circuits, 2014.
6. <https://www.theengineeringprojects.com/2013/03/a-complete-tutorial-on-how-to-use-proteus-isis-ares.html>
7. <https://labcenter.s3.amazonaws.com/downloads/Tutorials.pdf>
8. <https://www.circuitstoday.com/proteus-software-introduction>

**18EEV05 COMPUTER AIDED DESIGN AND ANALYSIS OF ELECTRICAL SYSTEM****Course Objectives**

- To design the layout of Electrical power systems.
- To evaluate the various power system parameters.

**Programme Outcomes (POs)**

c.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.

d.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.

e.Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations

m.Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

**Course Outcomes (COs)**

1. Design the layout of the electrical power system using E-CAD
2. Evaluate the electrical parameters of the power system using power world simulator

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	3	2	3	-	-	-	-	-	-	-	3	-
2	-	-	3	3	3	-	-	-	-	-	-	-	3	-

**UNIT 1****13 hours****LAYOUT USING E-CAD**

Basic design considerations – Electrical layout of power system single line diagram - distribution substation of 11kV and 66kV - multiple bus bar schemes - substation with protective devices and safety measures - wiring scheme in residential building –Industrial layout design-using E-CAD.

**UNIT 2****12 hours****POWER SYSTEM PLANNING**

Power system evaluation studies – Load flow analysis – Short circuit analysis – Power factor improvement – Contingency analysis – Congestion management – using Power world simulator

**MACRO AND MINI PROJECT****5 hours****Total : 30 Hours****Reference(s)**

1. Hadi Saadat, Power System Analysis, PSA Publishers, New Delhi, 2013.
2. P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan, Electrical Power Systems Analysis, Security and Deregulation, PHI Learning Private Limited, New Delhi, 2012.
3. I.J.Nagrath, D.P.Kothari, Power System Engineering, Tata McGraw Hill Ltd, New Delhi, 2017.
4. J.Duncan Glover, Mulukutla S.Sarma, Thomas J. Overbye, Power System Analysis and Design, Cengage Learning India Private Limited, 2012.
5. Sham Tickoo, AutoCAD Electrical 2020: A Tutorial Approach, Cadcim Technologies, USA, 2020.
6. Gaurav Verma, Matt Weber, AutoCAD Electrical 2018 Black Book, BPB Publications, 2018.

## 18EEV06 DESIGN OF POWER CONVERTERS FOR ELECTRICAL MACHINES

### Course Objective

- To design and analyse the performance characteristics of Rectifier using PSIM Software
- To design and analyse the characteristics of Choppers and regulators using PSIM Software
- To design and develop the inverter topology and its control techniques
- To design and analyse the electrical machines using Maxwell Software
- To analyse the Inverters and Controllers using MATLAB

### Program Outcomes(POs)

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Identify, formulate, review research literature, and analyze electrical engineering problems for reaching substantiated conclusions using principles of Electric Circuits, Electronic Devices, Electrical Machines, and Power systems
- e. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- m. Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

### Course Outcome(COs)

- Analyse the rectifier circuits through simulation tool using PSIM
- Analyse the performance of Chopper and regulator converters using PSIM
- Analyse and evaluate the performance of Inverter using PSIM
- Design and analyse the performance of Electrical machines using Maxwell
- Design a power converter for rectification and inversion process using MATLAB.

### Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	-	-	3	-	-	-	-	-	-	-	3	-
2	3	3	-	-	3	-	-	-	-	-	-	-	3	-

### UNIT I

#### DESIGN OF RECTIFIERS USING PSIM

**5 Hours**

Diode Bridge Rectifier with and without Capacitor Filter – Single phase full converter with RL load – Three Phase Full Converter with RL load – Input current Harmonic Analysis for Rectifiers – SemiConverter with RL load – Source Inductor Effect in Three phase full converter

### UNIT II

#### DESIGN OF CHOPPERS AND VOLTAGE REGULATORS USING PSIM

**5 Hours**

Pulse Generation using Comparator - Buck Converter – Boost Converter – Buck Boost Converter– Forward Converter for Battery Charging Circuit- Single phase AC to AC converter with R load – Three Phase converter with R load – Load Angle for RL load – Single phase converter with RL load

### **UNIT III**

#### **DESIGN OF INVERTERS USING PSIM**

**5 Hours**

Single phase square wave Inverter – Sine Pulse width Modulation Techniques – Single phase SPWM Inverter – Three Phase SPWM Inverter – Three phase Induction Motor speed control - PID Controllers - Closed loop voltage control of Boost Converter - Closed Loop control of PWM rectifiers

### **UNIT IV**

#### **DESIGN OF ELECTRICAL MACHINES USING ANSYS MAXWELL SOFTWARE**

**5 Hours**

Design of primary winding, secondary winding and transformer core - Design of stator and rotor of three phase induction motor and performance analysis - Design of stator and rotor of permanent magnet generators and performance analysis

### **UNIT V**

#### **DESIGN OF POWER CONVERTERS AND INVERTERS FOR ELECTRIC VEHICLE APPLICATIONS**

**5 Hours**

Uncontrolled rectifiers-half wave rectifier-full wave rectifier, Controlled rectifiers-half wave rectifier-full wave rectifier, Analysis of inverters-single phase voltage source inverter-three phase voltage source inverter-current source inverter-z source inverters.

#### **Reference(s)**

**TOTAL : 30 Hours**

1. Stanisław Szablowski, Teaching Power Electronics: Simulation Studies using PSIM Software, New Delhi 2019.
2. Design of rotating Electrical Machines, Juha Pyrhönen, Tapani Jokinen and Valeria Hrabovcova © 2008 John Wiley & Sons, Ltd. ISBN: 978-0-470-69516-6
3. Power Electronics with MATLAB by L. Ashok Kumar, A. Kalaiarasi, Y. Uma Maheswari, Cambridge University Press, 2017.
4. Practical Electrical Engineering by Makarov, Sergey, Ludwig, Reinhold, Bitar, Stephen J, Springer International Publishing, 2019.
5. MATLAB for Electrical Engineers and Technologists: MATLAB Tutorial with Practical Electrical Examples by Stephen Philip Tubbs, Stephen P. Tubbs, 2010.

**Course Objectives**

- Understand the application of load forecasting tools.
- Understand the real power-frequency relationship and the need for developing the mathematical model of Load Frequency Control Loop.
- Understand the reactive power-voltage relationship and the necessity of voltage compensation.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
  - Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - 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.
  - Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- m.PSO1: Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

**Course Outcomes (COs)**

- Apply the load forecasting tools to estimate the generation and reserve capacity
- Apply the concept of Laplace transform to construct the transfer function model of isolated and interconnected systems.
- Predict the transfer function model of excitation system and to classify system level voltage control methods
- Apply the iterative techniques to determine economical operating point of generating units
- Analyse the functions of load dispatch centers at National, Regional and State Levels.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	-	-	-	-	-	-	-	-	-	-	3	2
2	3	3	-	-	-	-	-	-	-	-	-	-	3	2
3	3	2	-	-	-	-	-	-	-	-	-	-	3	2
4	3	3	-	-	-	-	-	-	-	-	-	-	3	2
5	3	-	-	-	2	-	-	-	-	-	-	-	3	2

**UNIT I**

9

**Hours****INTRODUCTION**

System load variation: System load characteristics, load curves, Load-duration curve, load factor and diversity factor. Reserve requirements: Installed reserves, spinning reserves, cold reserves and hot reserves. Overview of system operation: Load forecasting, unit commitment and load dispatching. Overview of system control, Need for voltage and frequency regulation in power system, Plant level and System level controls.

**UNIT II**

**10 Hours**

**REAL POWER - FREQUENCY CONTROL**

Fundamentals of speed governing mechanism and modeling: Speed-load characteristics-Load sharing between two synchronous machines in parallel; concept of control area, LFC control of a single-area system: Static and dynamic analysis. Multi-area systems: Two-area system modeling; static analysis; tie line with frequency bias control of two-area system. State variable model.

**UNIT III**

**9 Hours**

**REACTIVE POWER VOLTAGE CONTROL**

Typical excitation system, modeling, static and dynamic analysis, stability compensation; generation and absorption of reactive power: Relation between voltage, power and reactive power at a node – method of voltage control - tap-changing transformer - System level control using generator voltage magnitude setting - tap setting of OLTC transformer and MVAR injection of switched capacitors to maintain acceptable voltage profile and to minimize transmission loss.

**UNIT IV**

**9 Hours**

**POWER SYSTEM ECONOMICS**

Incremental cost curve, Unit Commitment and its constraints, Solution to unit commitment problem using priority list method- Economic Dispatch - co-ordination equations without loss and with loss, solution by direct method and lambda iteration method. (No derivation of loss coefficients.) Base point and participation factors. Economic dispatch controller added to LFC control.

**UNIT V**

**8 Hours**

**COMPUTER CONTROL OF POWER SYSTEMS**

Energy control centre: Functions, Monitoring, data acquisition and control. System hardware configuration - SCADA and EMS functions: Network topology determination, security analysis and control. Various operating states: Normal, alert, emergency, in extremis and restorative. State transition diagram showing various state transitions and control strategies.

**Total: 45 Hours**

**Reference(s)**

1. Olle. I. Elgerd, "Electric Energy Systems Theory", Tata McGraw Hill Publishing Company Ltd, New Delhi, Second Edition, 2017.
2. Allen.J.Wood and Bruce F.Wollenberg, "Power Generation, Operation and Control", John Wiley & Sons Inc., New York 2013.
3. P.Kundur, Om P. Malik, "Power System Stability and Control", Tata McGraw Hill Book Company, New Delhi, 2022.
4. I.J. Nagarath, D.P. Kothari, "Modern Power System Analysis", Tata McGraw Hill Publishing Company, New Delhi, 2022.
5. P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan, "Electrical Power Systems Analysis, Security and Deregulation", PHI Learning Private Limited, New Delhi, 2017

**21EE002 /21EEH02/21EEM02 POWER QUALITY 3 0 0 3**

**Course Objectives**

- To analysis the various power quality phenomenon, their origin and effects.
- To summarize the causes and impacts of various power quality issues.
- To understand the methods of power quality monitoring and standards.
- To analysis the performance of passive compensators for mitigating the power quality issues.
- To design the active compensators for load compensation.

**Programme Outcomes (POs)**

- a. The Graduate will be able to apply the core knowledge to identify, formulate, and solve problems in power electronics and drives systems.
  - b. The Graduate will be able to apply knowledge in mathematics, science, electric and electronic circuits to develop and analyze mathematical models for power electronic and controllers.
  - c. The Graduate will be able to design power electronic circuits for industrial and commercial applications with due consideration on public health, safety and environmental constraints with sustainability and ethical responsibility.
- m.PSO1: Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n.PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Analysis the different types of power quality problems like sag, swell, under voltage, overvoltage, inter harmonics and etc., with their source of generation.
2. Identify the various causes and impacts of power quality issues due to commercial, domestic and industrial loads.
3. Understand different methodologies for monitoring, detection and classification of power quality problems.
4. Analysis the behavioural performance of passive shunt and series filters for mitigating the power quality issues generated in power systems.
5. Design and analysis of FACTS controllers like distribution static compensator, dynamic voltage regulator and etc., for enhancing the quality of power.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO
1	2	1	-	-	-	-	-	-	-	-	-	-	1	1
2	1	2	-	-	-	-	-	-	-	-	-	-	1	1
3	2	-	2	-	-	-	-	-	-	-	-	-	3	1
4	2	1	2	-	-	-	-	-	-	-	-	-	3	1
5	2	1	3	-	-	-	-	-	-	-	-	-	2	1

**UNIT I**

**9 Hours**

**INTRODUCTION TO POWER QUALITY**

Electric power quality phenomena. Classifications, characteristics and causes of short duration variation like sag, swell and interruption - Long duration variation like under voltage, over voltage and sustained interruption – Transients, voltage imbalance, power frequency variations and waveform distortion like harmonics and DC offset.

**UNIT II**

**9 Hours**

**CAUSES AND IMPACTS OF POWER QUALITY ISSUES**

Voltage sag due to faults, induction motor starting and transformer energizing. Over voltages due to capacitor switching, lightning and Ferro resonance. Harmonic sources from commercial and industrial loads. Classification and analysis of nonlinear loads. Effects of various power quality issues.

**UNIT III**

**9 Hours**

**POWER QUALITY MONITORING AND**

Monitoring considerations. Power Quality Measurement - wiring and grounding test devices, disturbance analyzers, Harmonic / spectrum analyzers and flicker meters. Smart power quality monitors, Expert system for power quality monitoring - IEEE and IEC standards.

**UNIT IV**

**9 Hours**

**PASSIVE COMPENSATION**

Passive power filters - classifications, operations, design, modelling and performance analysis of passive shunt and series filters.

**UNIT V**

**9 Hours**

**ACTIVE COMPENSATION**

FACTS devices: Classifications, operation, control methods, design and performance analysis of DSTATCOMs, DVRs and UPQCs.

**FOR FURTHER READING**

Estimation of voltage sag performance – Protection of overhead line, underground cables and transformers – Sag and harmonic indices – Harmonic distortion evaluation – Loads that causes the power quality problems.

**Total: 45 Hours**

**Reference(s)**

1. Roger. C. Dugan, Mark. F. McGranaghan, Surya Santoso, H.Wayne Beaty, “Electrical Power Systems Quality”, McGraw Hill, 2017.
2. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, "Power Quality: Problems and Mitigation Techniques", John Wiley & Sons, 2015.
3. Heydt, G.T., “Electric Power Quality”, Stars in a Circle Publications, Indiana, 2nd edition 1996.
4. Arrillaga, J, Watson, N.R., Chen, S., “Power System Quality Assessment”, Wiley, New York, 2011.
5. M.H.J Bollen, "Understanding Power Quality Problems: Voltage Sags and Interruptions", (New York: IEEE Press, 2011.

**21EE003/21EEH03/21EEM03 HIGH VOLATGE TRANSMISSION**

**3 0 0 3**

**Course Objectives**

- To understand the concept of HVAC and HVDC transmission systems
- To understand the concept of conductor and insulator design
- To explore the methods to convert high-voltage AC to high-voltage DC
- To predict the fault and provide proper protection to HVAC & HVDC transmission systems
- To classify the various filters used to mitigate the harmonics

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
  - b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - c. 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.
  - d. 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.
- m.PSO1: Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n.PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Analyze the performance of HVAC system components.
2. Analyze the power transfer capabilities and power flow control in HVAC.
3. Analyze the characteristics of high voltage power converters in HVDC.
4. Apply suitable methods to measure and predict the faults in HVDC.
5. Analyze the harmonics mitigation technique using filters.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	2	-	-	-	-	-	-	-	-	3	3
2	3	3	2	3	-	-	-	-	-	-	-	-	3	3
3	3	2	2	2	-	-	-	-	-	-	-	-	3	3
4	3	2	2	3	-	-	-	-	-	-	-	-	3	3
5	3	2	2	3	-	-	-	-	-	-	-	-	3	3

**UNIT I**

**HVAC CABLE DESIGN**

**9 Hours**

Design aspects of HVAC – conductor, tower, insulator and substation structure, design of EHVAC lines bas steady state limits and transient over voltages - design of extra HV cables - XLPE cables and gas insulated cable.

**UNIT II**

**HVAC POWER FLOW CONTROL**

**9 Hours**

Real and reactive power flows in HVAC systems – reactive power compensation, short circuit level & real power transfer capacity. Stability- voltage stability and control. Theory of travelling and stationary waves.

**UNIT III**

**9 Hours**

**HVDC TRANSMISSION SYSTEM**

Introduction to HVDC transmission - Bridge representation, power reversal, desired features of control and actual control characteristics.

**UNIT IV**

**9 Hours**

**HVDC PROTECTION AND CONTROL**

Basic HVDC controllers, converter faults, commutation failure, bypass action in bridges, protection issues in HVDC - DC reactors, voltage and current oscillations, DC circuit breakers and over-voltage protection.

**9 Hours**

**UNIT V**

**HARMONICS MITIGATION AND HYBRID HVDC**

Harmonics in HVDC - characteristics and uncharacteristic harmonics, troubles due to harmonics, harmonic filters – active and passive filters. Introduction to Hybrid HVDC-Design aspects of Hybrid HVDC system.

**Total: 45 Hours**

**Reference(s)**

1. S.Rao, “EHV-AC, HVDC Transmission and Distribution Engineering”, Khanna Publishers, 3<sup>rd</sup> Edition, 2018.
2. Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering”, New Age International Publishers, 3rd Edition, 2019.
3. Padiyar K.R., “HVDC Transmission Systems”, New Age International Publishers, 2nd Revised Edition, 2018.
4. C.L. Wadhwa, “High Voltage Engineering”, Wiley Eastern Limited, 2019.
5. E.Kuffel and M. Abdullah, “High Voltage Engineering”, Pergamon Press, 2019.
6. Alston, “High Voltage Technology” BS Publications, 2017.

**21EE004//21EEH04/21EEMO4 DEMAND SIDE MANAGEMENT****3 0 0 3****Course Objectives**

- To understand the energy scenario.
- To understand fundamentals of smart grid.
- To understand the concept of demand side management.
- To understand the economics of demand side management programs.
- To apply the cost effectiveness of demand side management.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- 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.
- PSO1: Design, analyze, and evaluate the performance of Electrical and Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Analyse the Energy Conservation Schemes through interpretation of energy audit results
- Apply the concept of current and voltage flow to perform distribution load flow analysis.
- Apply the concept of load forecasting to monitor the energy scenario.
- Analyze the distribution system by performing demand side management
- Analyze the economics effectiveness of demand side management.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	2	-	-	-	-	-	-	-	-	2	2
2	3	2	2	2	-	-	-	-	-	-	-	-	2	2
3	3	2	2	2	-	-	-	-	-	-	-	-	2	2
4	3	2	2	2	-	-	-	-	-	-	-	-	2	2
5	3	3	3	3	-	-	-	-	-	-	-	-	2	3

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

Energy Audit- Concept, Energy Index, Cost Index, Pie Charts, Sankey Diagrams, Load Profiles, Energy Conservation Schemes; Measurements in Energy Audits, Presentation of Energy Audit Results

**UNIT II** **9 Hours**

**LOAD FLOW ANALYSIS**

Radial Distribution Network - Distribution load flow – Load flow analysis of balanced radial distribution system - Load flow analysis of unbalanced radial distribution system - Load flow analysis of balanced weakly meshed distribution system

**UNIT III** **9 Hours**

**LOAD FORECASTING**

Power Loads, Connected Load - Load Forecasting; Regression Analysis, Correlation Theory - Factors in Power System Loading - Unloading the System - Forecast of System Peak, Strategic Forecasting, Spatial Load Forecasting - Scenario Planning - Sources of Error: Regulating the Model.

**UNIT IV** **9 Hours**

**DEMAND SIDE MANAGEMENT**

Demand Side Management – Concept, Techniques, Benefits; Time of Day Pricing, Multi-Utility Power Exchange Model, Time of Day Models for Planning; Load Management, Load Priority Technique, Peak Clipping, Peak Shifting, Valley Filling, Strategic Conservation, Energy Efficient Equipment. Management and Organization of Energy Conservation Awareness Programs

**UNIT V** **9 Hours**

**ECONOMICS OF DSM**

The time value of Money Concept, Cash flow model, Pay back analysis, Depreciation, Net present value calculations; Taxes and Tax Credit –Numerical Problems; Importance of evaluation, measurement and verification of demand side management programs

**Total: 45 Hours**

**Reference(s)**

1. A S. Pabla, Electric Power Distribution, Tata McGraw-Hill Education, 2019.
2. B. Das, Power Distribution Automation, IET Power and Energy Series, 75, London, 2016.
3. Albert Thumann, 'Fundamentals of Energy Engineering', CRC Press, 2015
4. W.R. Murphy & G. Mckay Butter worth, Energy management, Heinemann publications, 2003.
5. Ashok V. Desai, Energy Demand – Analysis, Management and Conservation, Wiley Eastern, 2005.

**21EE005/21EEH05/21EEM05 SMART GRID TECHNOLOGIES****3 0 0 3****Course Objectives**

- To summarize the components used in smart grid and technologies involved in smart grid.
- To understand the concept of smart metering and implementation of demand side integration.
- To analyze the concepts in automated distribution systems in smart grid.
- To analyze the concepts in automated transmission systems in smart grid.
- To analyze the significance of power electronics in smart grid.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- PSO1: Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.

**Course Outcomes (COs)**

- Examine the operating principles and models of Smart Grid components.
- Classify the protocols of smart metering used in demand Side Integration.
- Outline the distribution system automation in Smart Grid.
- Outline the transmission system automation in Smart Grid.
- Analyze the power quality improvement concepts in Smart Grid.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	-	-	-	3	-	-	-	-	-	-	-	3	-
2	2	-	-	-	3	-	-	-	-	-	-	-	3	-
3	2	-	-	-	3	-	-	-	-	-	-	-	3	-
4	2	-	-	-	3	-	-	-	-	-	-	-	3	-
5	2	-	-	-	3	-	-	-	-	-	-	-	3	-

**UNIT I****9 Hours****INTRODUCTI  
ON**

Electrical Grid - Definition of Smart Grid - Opportunities, Challenges and Benefits of Smart Grid - Inventory of Smart Grid Technologies - Operating Principles and Models of Smart Grid Components, Implementation of Smart Grid- Early Smart Grid initiatives - Overview of the technologies required for the Smart Grid.

**UNIT II****9 Hours****SMART METERING AND DEMAND-SIDE INTEGRATION**

Introduction - Smart metering - Smart meters- An overview of the hardware used- Communications infrastructure and protocols for smart metering, Demand-side integration- Services provided by DSI, Implementations of DSI, Hardware support to DSI implementations, Flexibility delivered by prosumers from the demand side, System support from DSI.

**UNIT III** **9 Hours**

**DISTRIBUTION AUTOMATION**

Distribution automation, automated meter reading (AMR), automated metering infrastructure (AMI), fault location isolation and service restoration (FLISR), Outage Management Systems (OMS), High Efficiency Distribution Transformers, Phase Shifting Transformers.

**UNIT IV** **9 Hours**

**TRANSMISSION SYSTEM AUTOMATION**

Substation automation, Feeder Automation, Supervisory control and data acquisition (SCADA), energy management system (EMS), phasor measurement units (PMU), Wide area monitoring systems (WAMS).

**UNIT V** **9 Hours**

**POWER ELECTRONICS IN THE SMART GRID**

Fault current limiting Shunt compensation, D-STATCOM, Active filtering, Shunt compensator with energy storage, FACTS- Reactive power compensation, Series compensation, Unified power flow controller.

**FOR FURTHER READING**

Smart appliance Technology - Pricing for Smart Appliances on demand. Security issues in DG, Distribution Automation, AMI, Electric Vehicle Management Systems - Approach to assessment of smart grid cyber security risks - Methodologies.

**Total: 45 Hours**

**References:**

1. Bimal K Bose, "Power electronics in renewable energy systems and smart grid: technology and applications", IEEE Press, 2019.
2. B. Vinoth Kumar, P. Sivakumar, M.M. Rajan Singaravel, K. Vijayakumar, "Intelligent Paradigms for Smart Grid and Renewable Energy Systems", Springer, 2021.
3. Omar Ellabban, Shady S Refaat, Sertac Bayhan, Haitham Abu-Rub, Frede Blaabjerg, Miroslav Begovic, "Smart Grid and Enabling Technologies", Wiley - IEEE, 2021.
4. M. Kathiresh , A. Mahaboob Subahani , G. R. Kanagachidambaresan , "Integration of Renewable Energy Sources with Smart Grid", Wiley-Scrivener, 2021.
5. Ali Keyhani, " Design of smart power grid renewable energy systems", Wiley,2020.

**21EE006/21EEH06/21EEM06 POWER SYSTEM DEREGULATION****3 0 0 3****Course Objectives**

- To Understand the need for restructuring of Power Systems, different market models and market power.
- To Understand the market model, operations and challenges faced in a deregulation environment.
- To Understand the transmission open access and congestion management methods.
- To apply the concepts and terminologies in pricing methodology and available transfer capability.
- To Understand the reforms in the Indian Power Sector and for future expansion.

**Programme Outcomes (POs)**

- Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- Modeling, design and Analysis of Electrical and Electronic Systems using design principles and software tools
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and Ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Analyze the restructuring process, new entities in power market and benefits.
2. Explain the challenges faced in a deregulation environment with their market model and operations.
3. Analyze the transmission open access and congestion management methods.
4. Compute the pricing of power transactions and available transfer capability in a deregulation environment.
5. Elaborate the reforms in Indian Power Sector and in future.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	-	-	-	-	-	-	-	-	-	-	3	-
2	3	2	-	2	-	-	-	-	-	-	-	-	3	1
3	2	-	-	2	3	-	-	-	-	-	-	-	3	2
4	2		-	--	3	-	-	-	-	-	-	-	3	2
5	3	2	-	3	-	-	-	-	-	-	-	-	3	-

**UNIT I****9 Hours****POWER SYSTEM DEREGULATION: AN OVERVIEW**

Introduction- Motivation for Restructuring of Power System- Electricity Market Entities and Model- Milestones of Deregulation-International Scenario - Benefits of deregulation- Basic Terminologies.

**UNIT II**

**9 Hours**

**COMPETITIVE WHOLESALE ELECTRICITY MARKET**

Introduction - Restructuring models - Role of Independent system operator - Power exchange (PX) - Market Clearing Price (MCP) - Market operations - Whole sale electricity market characteristics - Challenges in wholesale electricity market.

**UNIT III**

**9 Hours**

**TRANSMISSION OPEN ACCESS**

Introduction - Transmission open access- Types of Transmission services in open access - FERC order 889 - Structure of OASIS: Functionality and Architecture of OASIS - Congestion management - congestion management methods: An overview: Rescheduling of generation-Power World Simulation model.

**UNIT IV**

**10 Hours**

**PRICING AND AVAILABLE TRANSFER CAPABILITY**

Introduction - Transmission cost components - Transmission pricing methods - Postage stamp method - contract path method-MW Mile method - Marginal participation method - Available Transfer Characteristics (ATC): Introduction -Definition - Methods of Static ATC Determination - Method based on multiple load flow and continuation power flow - method based on linear sensitivity factors - Power World Simulation model.

**UNIT V**

**8 Hours**

**INTERNATIONAL AND INDIAN POWER MARKET**

Introduction - California Markets - New York Markets - PJM interconnection - Indian power sector past and present status-growth of power sector in India - overview - Time line of Indian power sector- Players in the Indian power sector.

**FOR FURTHER READING**

Electric Energy Trading, Electricity Price Forecasting, Demand Side Management

**Total: 45 Hours**

**Reference(s)**

1. M.Shahidepour, Hatim Tamin and Zuyi Li, "Market operations in electric power system forecasting,scheduling and risk management", John Wiley sons, 2002.
2. M.Shahidepour and M. Alomoush, "Restructured Electrical Power Systems: Operation: Trading, and Volatility", Marcel Dekker, Inc., 2001.
3. P.Venkatesh, B.V.Manikandan, S.Charles Raja and A.Srinivasan, "Electrical power systems analysis,Security and Deregulation", PHI 2012.
4. Loi Lei Lai, "Power system Restructuring and Deregulation" John Wiley sons, 2001.
5. Kankar Bhattacharya Maath H.J. Bollen and Jaap E.Daalder, "Operation of restructured power systems",Kluwer academic publishers, USA, first edition, 2001.

**21EE007 ADVANCED POWER SEMICONDUCTOR DEVICES****3 0 0 3****Course Objectives**

- To learn the characteristics of different types of semiconductor devices.
- To analyze the characteristics of power transistor
- To understand the construction and working principle of Thyristor
- To understand the operation and analyze the characteristics of power controlled devices
- To explore the need for isolation circuits and protection circuits

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an Engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Examine the performance characteristics of ideal and practical switches
2. Assess the performance characteristics of power transistor
3. Analyze the static and dynamic characteristics of thyristor
4. Analyze the static and switching characteristics of power controlled devices
5. Design a snubber and driver circuits for power controlled devices

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	-	-	-	-	-	-	-	-	-	-	3	-
2	3	1	-	-	-	-	-	-	-	-	-	-	3	-
3	3	1	-	-	-	-	-	-	-	-	-	-	3	1
4	3	1	-	-	-	-	-	-	-	-	-	-	2	1
5	2	1	3	-	-	-	-	-	-	-	-	-	3	2

**NITI****9 Hours****INTRODUCTION**

Power switching devices -Attributes of an ideal switch, application requirements- circuit symbols -Power handling capability (SOA); Device selection strategy - On-state and switching losses - EMI due to switching - Power diodes - Types, forward and reverse characteristics, switching characteristics -

Rating.Introduction to wide band gap semiconductors such as silicon carbide and gallium nitride.

**UNIT II**

**9 Hours**

**POWER TRANSISTOR**

BJTs - Construction, static characteristics, switching characteristics - Negative temperature coefficient and Secondary breakdown - Power Darlington - Thermal protection-dynamic models of BJT

**UNIT III**

**9 Hours**

**THYRISTOR**

Thyristors - working principle and its operating modes- Two transistor analogy- concept of latching - Gate and switching characteristics - Converter grade and inverter grade and other types; series and parallel Operation -Comparison of BJT and Thyristor- Steady state and dynamic models of BJT and Thyristor - thermal protection

**UNIT IV**

**9 Hours**

**POWER CONTROLLED DEVICES**

Principle, construction, types of Power MOSFETs and IGBTs- static and switching characteristics -Steady state and dynamic models of MOSFET and IGBTs; Basics of GTO, MCT, and IGCT

**UNIT V**

**9 Hours**

**FIRING AND PROTECTING CIRCUITS**

Necessity of isolation circuit- Pulse transformer- Opto-coupler; Gate drive circuit for SCR, MOSFET, IGBTs and base driving for power BJT - Overvoltage, over current and gate protections, Design of snubbers.

**Total: 45 Hours**

**Reference(s)**

1. Timothy L. Skvarenina, "The power electronics handbook", CRC press, New Delhi, 2012.
2. M. H. Rashid, "Power Electronics circuits, Devices and Applications", Prentice Hall of India, New Delhi, 2011.
3. Shen, Shyh-Chiang, "Wide-bandgap device research and development at SRL", Georgia Institute of Technology Semiconductor Research Laboratory, retrieved 2014-09-03.
4. Baliga, B. Jayant, "Fundamentals of Power Semiconductor Devices", springer, 2008.
5. Ned Mohan, Undeland and Robins, " Power Electronics Concepts, applications and design", John Wiley and sons, Singapore, 2000.
6. D. Singh and K. B. Khanchandani, "Power Electronics", Tata McGraw Hill book Co, New Delhi, 2003.

**21EE008 ADVANCED POWER CONVERTERS****3 0 0 3****Course Objectives**

- To analyze the closed loop operation of switched mode power supplies.
- To understand the operation of switched mode rectifiers.
- To understand and analyze the various types of multilevel inverters.
- To evaluate the operation, and performance parameters of matrix converters .
- To understand the operation of soft switched power converters.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
  - Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - 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.
  - 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.
- m.PSO1: Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n.PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Apply the various converter topologies to design and analyze the switched mode power supplies.
- Evaluate the input and output parameters of controlled rectifiers with PWM techniques.
- Analyze the operation of advanced multilevel inverters with different modulation schemes.
- Analyze the performance parameters of AC- AC converters with and without DC link.
- Apply the soft switching techniques and analyze the performance of hard switched and soft switched converters.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	3	-	-	-	-	-	-	-	-	2	2
2	3	2	2	3	-	-	-	-	-	-	-	-	3	2
3	3	2	2	3	-	-	-	-	-	-	-	-	3	2
4	3	2	2	3	-	-	-	-	-	-	-	-	3	2
5	3	2	2	3	-	-	-	-	-	-	-	-	3	2

**UNIT I****9 Hours****SWITCHED MODE POWER SUPPLIES (SMPS)**

DC Power supplies and Classification; Switched mode dc power supplies - with and without isolation, single and multiple outputs- Closed loop control and regulation- Design examples on converter and closed loop performance.

**UNIT II**

**AC-DC CONVERTERS**

Switched mode AC-DC converters-synchronous rectification - single and three phase topologies - switching techniques - Power Factor: power factor improvement techniques- reduced input current harmonic distortion -with and without input-output isolation.

**UNIT III**

**9 Hours**

**DC-AC CONVERTERS**

Multi-level Inverter-operation with equal and unequal DC voltages, - Inverters for open ended load configurations - Carrier modulation schemes of multilevel inverter, SVPWM of Multilevel inverter, Neutral Point Balancing schemes.

**UNIT IV**

**9 Hours**

**AC-AC CONVERTERS WITH AND WITHOUT DC LINK**

Matrix Converters-Modulation techniques - scalar modulation, indirect modulation-Matrix converter as only AC-DC converter-AC-AC converter with DC link - topologies and operation - with and without resonance link - converter with dc link converter.

**UNIT V**

**9 Hours**

**SOFT-SWITCHING POWER CONVERTERS**

Soft switching techniques-ZVS, ZCS, quasi resonance operation-Performance comparison hard switched and soft switched converters-AC-DC converter, DC-DC converter, DC-AC converter- Resonant DC power supplies.

**Total: 45 Hours**

**FURTHER READING(s)**

Dual active bridge, resonant inverters-High frequency magnetics-Emerging power semi-conductor devices.

**Reference(s)**

1. Muhammad H.Rashid, "Power Electronics Circuits, Devices & Applications", 4th Edition, Pearson India, 2018.
2. Ned Mohan, Tore. M. Undeland, William. P. Robbins, "Power Electronics: Converters, Applications and Design", 3rd Edition Wiley India, NewDelhi, 2012.
3. M.D.Singh & K.B Khanchandani, "Power Electronics", 2nd Edition, Tata Mc Graw Hill Publishing Co.Ltd., New Delhi, 2017.
4. Robert W.Erickson, Dragan Maksimovic, "Fundamentals of Power Electronics", Soringer Nature Switzerland AG 2020.
5. Marian P.Kazmierkowski, R.Krishnan and Frede Blaabjerg, "Control in Power Electronics- Selected Problem",Academic Press (Elsevier Science), 2002.
6. José Rodríguez, , Jih-Sheng Lai, and Fang Zheng Peng, "Multilevel Inverters: A Survey of Topologies, Controls, and Applications", IEEE Trans. Ind. Electron., Vol. 49, No. 4, August 2002.

## 21EE009 MODERN RECTIFIERS AND RESONANT CONVERTERS

3 0 0 3

### Course Objectives

- To understand the importance of harmonics standards and operation of rectifiers in CCM & DCM.
- To analyze and design power factor correction rectifiers for UPS applications.
- To understand the source current shaping methods for rectifiers.
- To understand the resonant converters for SMPS applications.
- To analyze the performance of DC-DC Converters.

### Programme Outcomes (POs)

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- m. PSO1: Design, analyze, and evaluate the performance of Electrical and Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

### Course Outcomes (COs)

1. Understand the types of modern rectifiers and its applications.
2. Analyze the performance of PWM inverters for specific applications.
3. Analyze the characteristics of resonant converters for different loads.
4. Apply the working linear system, state space model, PI controller.
5. Design a DC power supplies using advanced controller logic.

### Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	-	-	-	1	-	-	-	--	-	2	3
2	3	2	3	-	-	-	-	-	-	-	-	-	3	3
3	2	3	3	-	-	-	-	-	-	-	-	-	3	3
4	3	2	3	-	-	-	-	-	-	-	-	-	3	3
5	2	3	2	-	-	-	1	-	-	-	-	-	3	3

### UNIT I

9 Hours

#### LINE COMMUTATED RECTIFIERS

AC line current harmonic standards IEC1000-IEEE 519-CCM and DCM operation of single phase full wave rectifier- Behaviour of full wave rectifier for large and small values of capacitance - CCM and DCM operation of three phase full wave rectifier- 12 pulse converters- Multi Pulse converters - Harmonic trap filters

**UNIT II** **9 Hours**  
**PULSE WIDTH MODULATED RECTIFIERS**

Properties of Ideal single phase rectifiers-Realization of nearly ideal rectifier-. Single-phase converter systems incorporating ideal rectifiers - Losses and efficiency in CCM high quality rectifiers -Single-phase PWM rectifier - device selection for rectifiers - Three phase PWM rectifier - applications of rectifiers

**UNIT III** **9 Hours**  
**DYNAMIC ANALYSIS OF SWITCHING CONVERTERS**

Review of linear system analysis-State Space Averaging-Basic State Space Average Model State Space Averaged model for an ideal Buck Converter, ideal Boost Converter, ideal Buck Boost Converter and an ideal Cuk Converter. Pulse Width modulation - Voltage Mode PWM Scheme - Current Mode PWM Scheme - Design of PI controller.

**UNIT IV** **9 Hours**  
**RESONANT CONVERTERS**

Soft Switching - classification of resonant converters - Quasi resonant converters- basics of ZVS and ZCS- half wave and full wave operation (qualitative treatment) - multi resonant converters - operation and analysis of ZVS and ZCS multi resonant converter - zero voltage transition PWM converters - zero current transition PWM converters

**UNIT V** **9 Hours**  
**SOURCE CURRENT SHAPING OF RECTIFIERS**

Need for current shaping - power factor - functions of current shaper - input current shaping methods - passive shaping methods -input inductor filter - resonant input filter - active methods - boost rectifier employing peak current control - average current control - Hysteresis control Nonlinear carrier control.

**FOR FURTHER READING**

Zeta Converter, Push Pull converter, Space vector modulation

**Total: 45 Hours**

**Reference(s)**

1. Robert W. Erickson and Dragon Maksimovic, "Fundamentals of Power Electronics", Second Edition, Springer science and Business media,2001.
2. William Shepherd and Li Zhang, "Power Converters Circuits", Marcel Dekker, 2005.
3. Simon Ang and Alejandro Oliva, "Power Switching Converters", Taylor & Francis Group, 2010.
4. Andrzej M. Trzynadlowski, " Introduction To Modern Power Electronics", John Wiley & Sons, 2016.
5. Marian.K.Kazimierczuk and Dariusz Czarkowski, "Resonant Power Converters", John Wiley & Sons limited, 2011.
6. D. Grahame Holmes; Thomas A. Lipo, "Pulse Width Modulation for Power Converters: Principles and Practice", Wiley-IEEE Press, 2003.

21EE010

**ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY**

3 0 0 3

**Course Objectives**

- Acquire knowledge on electromagnetic interference and electromagnetic compatibility.
- To understand the EMI and EMC standards
- To understand the EMI in electric circuits.
- To interpret the Noise suppression techniques.
- To select the appropriate EMI filtering methods.

**Programme Outcomes (POs)**

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

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

PO3: 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 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.

PSO1: Design, analyze, and evaluate the performance of Electrical and Electronics systems using contemporary tools to provide effective solutions for real-world problems.

PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Analyse the types and sources of EMI.
2. Apply the suitable measurement techniques and standards for EMI problems
3. Evaluate the EMI in electrical circuits
4. Apply appropriate techniques to control EMI .
5. Design a filter to suppress the EMI.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	3	-	-	-	-	-	-	-	-	2	2
2	3	2	2	3	-	-	-	-	-	-	-	-	3	2
3	3	2	2	3	-	-	-	-	-	-	-	-	3	2
4	3	2	2	3	-	-	-	-	-	-	-	-	3	2
5	3	2	2	3	-	-	-	-	-	-	-	-	3	2

**UNIT I**

**9 Hours**

**INTRODUCTION**

Sources of EMI- Inter systems and Intra systems EMI- Conducted and radiated interference- Characteristics -EMI predictions and modeling, - Methods of eliminating interferences- Design of electromagnetic compatibility (EMC)- EMC regulation typical noise path.

**9 Hours**

**UNIT II**

**EMI MEASUREMENT AND STANDARDS**

EMI Measuring Instruments, Test Equipment, Measurement of Interference Voltage and Current-Spectrum Analysers - EMI Measurements for Consumer Appliances, Standards: Basic Standards, Product Standards, IEC, ANSI, FCC, CISPR, BSI, CENELEC, ACEC and MIL61E standards.

**UNIT III**

**9 Hours**

**EMI IN ELEMENTS AND CIRCUITS**

Electromagnetic emissions, noise from relays and switches, non-linearity in circuits, passive intermodulation, transients in power supply lines, EMI from power electronic equipment, EMI as combination of radiation and conduction

**UNIT IV**

**9 Hours**

**NOISE SUPPRESSION TECHNIQUES**

Noise Suppression in Relay Systems, Application of ACS switching Relays, Application of RC – Snubbers to Power Semiconductors, Shielded Transformers, Capacitor Filters, EMI Generation and Reduction at Its Source, Influence of Layout and Control of Parasitic.

**UNIT V**

**9 Hours**

**EMI FILTER CIRCUITS**

Selection and Measurement, Test Methods, EMI Filter Design, -Insertion Loss, Design Method for Mismatched Impedance Condition, Design of EMI Filters with Common- Mode Choke Coils, Damped EMI Filters and Lossy Filter Elements.

**Total: 45 Hours**

**Reference(s)**

1. L. Tihanyi, "Electromagnetic compatibility in Power Electronics", IEEE press, 2020.
2. Bruce Archambeault, Colin Brench, Omar M. Ramahi, "EMI/EMC computational modelling handbook", Kluwer press, second edition, 2018.
3. D. Morgan, "A Handbook for EMC Testing and Measurement", IET Electrical Measurement Series, Band 8, 2018
4. Tim Williams, "EMC for product designers", Newnes press, fifth edition, 2016.
5. Henry W. Ott, "Noise reduction techniques in electronic systems", John Wiley & Sons, 1989.
6. José Rodríguez, , Jih-Sheng Lai, and Fang Zheng Peng, 'Multilevel Inverters: A Survey of Topologies, Controls, and Applications', IEEE Trans. Ind. Electron., Vol. 49, No. 4, August 2015.

**21EE011 ELECTRIC DRIVES AND CONTROL****3 0 0 3****Course Objectives**

- To understand the motor, load dynamics, their nature and classification.
- To Apply power electronic converters to control the speed of DC motors.
- To analyze the speed control techniques for induction motor drives
- To analyze the performance of synchronous motor drives.
- To select the special electrical machines and control schemes for various industrial applications

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
  - Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - 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.
- m. PSO1: Design, analyze, and evaluate the performance of Electrical and Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Understand the dynamics of electrical drives, their nature and classification
- Analyze the chopper fed DC drive.
- Analyze the speed control techniques of induction motor drives
- Analyze the performance of synchronous motor drives.
- Select the special electrical machines and apply control schemes for various industrial applications

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	1	-	-	-	-	-	-	-	-	-	2	
2	3	3	1	-	-	-	-	-	-	-	-	-	2	1
3	3	3	1	-	-	-	-	-	-	-	-	-	2	1
4	3	1	1	-	-	-	-	-	-	-	-	-	2	
5	3	1	1	-	-	-	-	-	-	-	-	-	1	2

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

Concepts, and classification of Electric drives. Selection of motors. Dynamics of Electric drives: Types of loads, Multi quadrant operations, motor dynamics steady state stability and transient stability. Rating and Heating of motors: Heating effects, heating and cooling curves, classes of duty, load equalization, environmental factors.

**UNIT II** **9 Hours**  
**DC MOTOR DRIVE**

Basic characteristics, Operating modes, Single phase and three phase controlled rectifier fed DC drives, Dual converters drives, Chopper drives, Rheostatic and regenerative braking, effects of changes in supply voltage and load torque, closed loop control schemes.

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

Induction motor drives, stator voltage control, stator impedance control, rotor voltage control – Slip power recovery schemes, V/f control, Current control method. Need for harmonic filter, Closed loop control. Introduction to vector control scheme.

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

Speed torque characteristics and torque angle characteristics. Fixed and variable frequency operation modes, Self-control modes.

**UNIT V** **9 Hours**  
**SPECIAL MACHINES**

Brushless DC motor, Switched Reluctance Motor, introduction to the relevant converter circuits.

**Total: 45 Hours**

**Reference(s)**

1. G. K. Dubey, et.al., “Thyristorised Power Controllers,” New Age International, 2002.
2. Vedam Subramanyan, Electric Drives: Concepts and Applications, Tata McGraw Hill Publishing Company, New Delhi, 2011.
3. Krishan. R, 'Permanent Magnet Synchronous and Brushless DC Motor Drives', CRC Press, 2010
4. Soumitra Kumar Mandal, Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085, 8086, 8051, McGraw Hill Education, 2013.
5. P. S. Bimbra Power Electronics, Khanna Publishers, third Edition, 2003.

## 21EE012 POWER ELECTRONIC INTERFACES FOR RENEWABLE ENERGY SOURCES

3 0 0 3

### Course Objectives

- To analyse the current scenario of the implementation of renewable energy system.
- To understand the modern power converters for solar thermal systems.
- To understand the interfacing of power converters with wind energy systems
- To understand the operations of various generators used in WECS.
- To analyse the distributed power generation systems.

### Programme Outcomes (POs)

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- m. PSO1: Design, analyze, and evaluate the performance of Electrical and Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

### Course Outcomes (COs)

1. Apply the rules and regulations for development of new energy technologies
2. Analyse the power converters for standalone solar power conversion system
3. Analyse the different configurations of wind energy conversion system
4. Analyze the converters for grid connected WECS and SECS
5. Apply the concepts of solar PV and wind energy conversion system to develop the distributed power generation system.

### Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	-	-	-	1	-	-	-	-	-	2	3
2	3	2	3	-	-	-	-	-	-	-	-	-	3	3
3	2	3	3	-	-	-	-	-	-	-	-	-	3	3
4	3	2	3	-	-	-	-	-	-	-	-	-	3	3
5	2	3	2	-	-	-	1	-	-	-	-	-	3	3

### UNIT I

9 Hours

#### INTRODUCTION

Trends in energy consumption - World energy scenario - Energy sources and their availability  
 - Conventional and renewable energy resources - Need to develop new energy technologies -  
 Current status of renewable energy sources - Government Bodies and its function - MNRE & TEDA.

## **UNIT II**

**9 Hours**

### **SOLAR PV SYSTEMS**

Solar radiation and measurements - Solar cells - Panels and their characteristics -Influence of insolation, temperature and parasitic capacitance PV arrays - power Converters-Maximum power point tracking - Applications.

## **UNIT III**

**9 Hours**

### **WIND ENERGY SYSTEMS**

Principle of Wind Energy Conversion System- Nature of Wind - Components of Wind Energy Conversion System- Modern generators for WECS - Power conditioning schemes.

## **UNIT IV**

**9 Hours**

### **GRID CONNECTED WECS AND SECS**

Grid codes- grid connectors -Grid related problems and standards-conventional and new grid synchronisation Methods-Generator control - Power converters for Grid connected WECS - Power converters for Grid connected SECS.

## **UNIT V**

**9 Hours**

### **DISTRIBUTED POWER GENERATION SYSTEMS**

Hybrid Systems - Selection of power conversion ratio -Optimization of System components -Micro Hydro, wind, solar, and fuel cell systems - Converters and controllers for integration of renewable energy sources- types of energy storage systems

### **FOR FURTHER READING**

Need for Hybrid Systems- Range and types of hybrid PV systems -SPV-Wind-Battery- fuel Cell-Diesel generator & grid interacted hybrid system - Micro hydro power - Co-generation

**Total: 45 Hours**

### **Reference(s)**

1. S. Rao and Parulekar, Energy Technology Non Conventional, Renewable and Conventional, New Delhi, Khanna Publishers, 1999.
2. Rai G.D, Non conventional energy sources, Khanna Publishers, 1993.
3. Mukund R. Patel, Wind and Solar Power System, New York, CRC Press LLC, 1999.
4. Ned Mohan, Tore M. Undeland and William P.Robbins, Power Electronics: Converters, Applications and Design, New Jersey, John Wiley and Sons, 2003.
5. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley and Sons, Ltd., 2011.

**21EE013 ELECTRIC VEHICLE ARCHITECTURE****3 0 0 3****Course Objectives**

- To understand the sizing and architecture of Electric vehicles.
- To apply the propulsion mechanics for Electric Vehicles.
- To analyse the power components and braking system for Electric Vehicles.
- To apply the various control strategies for Electric Vehicles.
- To apply the concepts of Plug-in Hybrid Electric Vehicle.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- 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.
- PSO1: Design, analyse, and evaluate the performance of Electrical and Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Illustrate the sizing of various components of Electric Vehicle.
- Design a propulsion system for Electric Vehicle.
- Analyse the power components and braking system for Electric Vehicles.
- Apply the various control strategies for Electric Vehicles.
- Implement the concept of plug-in hybrid electric vehicle.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	3	-	-	-	-	-	-	-	-	3	3
2	3	3	3	3	-	-	-	-	-	-	-	-	3	3
3	3	3	3	3	-	-	-	-	-	-	-	-	3	3
4	3	3	3	3	-	-	-	-	-	-	-	-	3	3
5	3	3	3	3	-	-	-	-	-	-	-	-	3	3

<b>UNIT I</b> <b>VEHICLE ARCHITECTURE AND SIZING</b> Electric Vehicle History, and Evolution of Electric Vehicles - Series, Parallel and Series Parallel Architecture, Micro and Mild architectures - Mountain Bike - Motorcycle- Electric Cars and Heavy Duty EVs. -Details and Specifications.	<b>9 Hours</b>
<b>UNIT II</b> <b>VEHICLE MECHANICS</b> Vehicle mechanics- Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire –Road mechanics, Propulsion System Design.	<b>9 Hours</b>
<b>UNIT III</b> <b>POWER COMPONENTS AND BRAKES</b> Power train Component sizing- Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Powertrain sizing, Example.	<b>9 Hours</b>
<b>UNIT IV</b> <b>HYBRID VEHICLE CONTROL STRATEGY</b> Classification of control strategies: series, parallel, and power split-Different operating modes of hybrid vehicles: electric-only, engine-only, hybrid, regenerative braking-Control strategies for optimizing energy management and efficiency.	<b>9 Hours</b>
<b>UNIT V</b> <b>PLUG-IN HYBRID ELECTRIC VEHICLE</b> Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging mechanisms-Advantages of PHEVs.	<b>9 Hours</b>

**Total: 45 Hours**

**Reference(s)**

1. Mehrdad Ehsani, Yimin Gao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.
2. Build Your Own Electric Vehicle, Seth Leitman, Bob Brant, McGraw Hill, Third Edition 2013.
3. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, First edition 2017.
4. The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and Bicycles -- Includes EV Components, Kits, and Project Vehicles Mark Warner, HP Books, 2011.
5. Heavy-duty Electric Vehicles from Concept to Reality, Shashank Arora, Alireza Tashakori Abkenar, Shantha Gamini Jayasinghe, Kari Tammi, Elsevier Science, 2021
6. Electric Vehicles Modern Technologies and Trends, Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen Springer, 2020
7. Hybrid Electric Vehicles: A Review of Existing Configurations and Thermodynamic Cycles, Rogelio León, Christian Montaleza, José Luis Maldonado, Marcos Tostado-Véliz and Francisco Jurado, Thermo, 2021, 1, 134–150. <https://doi.org/10.3390/thermo1020010>.

**21EE014 DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES**

**3 0 0 3**

**Course Objectives**

- To familiarize with power electronic components configuration to review the drive cycles and requirements of EVs
- To expose the utilization of different motors used in Electric Vehicle
- To learn the methods for analysing the behaviour of nonlinear control systems.
- To inculcate the knowledge to design and analyse power converters suitable for EV
- To design and analyse the transfer function of DC-DC converter used in EV

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- d. 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.
- m. PSO1: Design, analyze, and evaluate the performance of Electrical and Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Explain the various parameters in dynamics of electric vehicles.
2. Apply controls of different motors for drive system efficiency.
3. Derive linear quadratic optimal controllers for scalar systems, and evaluate design parameters influence the closed-loop system properties.
4. Design and analyse closed loop Power converters for EV.
5. Analyse power electronics circuits and losses occurring in practice.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3		3	-	-	-	-	1	-	3	-	3	3	-
2	3	3	3	3	3	-	-	1	-	3	-	3	3	3
3	3	3		3	3	-	-	1	-	3	-	3	3	3
4	3	3	3	3	3	-	-	1	-	3	-	3	3	3
5	3		3	3	3	-	-	1	-	3	-	3	3	3

**UNIT I** **9 Hours**

**ELECTRIC VEHICLE DYNAMICS**

Standard drive cycles-Dynamics of Electric Vehicles-Tractive force-Maximum speed, torque, power, energy requirements of EVs.

**UNIT II** **9 Hours**

**MOTORS FOR ELECTRIC VEHICLES**

Introduction – Speed And Torque control of above and below rated speed-Speed control of EV in the constant power region of electric motors. DC Motors, Induction Motor, Permanent Magnet Synchronous Motors (PMSM), Brushless DC Motors, Switched Reluctance Motors (SRMs). Synchronous Reluctance Machines-Choice of electric machines for EVs.

**UNIT III** **9 Hours**

**BASICS OF SIMULATION IN CONTROL SYSTEMS**

Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots, bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state space modelling-transfer function from state space Model

**UNIT IV** **9 Hours**

**MODELING OF DC-DC CONVERTERS**

Overview of PWM Converter Modelling -Power Stage Modelling - PWM Block Modelling - Voltage Feedback Circuit and Small-Signal Model of PWM Converter - Averaging Power Stage Dynamics - Average Models for buck/boost Converter - Small-Signal Model of Converter Power Stage - Frequency Response of Converter

**UNIT V** **9 Hours**

**POWER STAGE TRANSFER FUNCTIONS OF DC – DC CONVERTERS**

Power Stage Transfer Functions of buck-boost Converter in CCM Operation, Input-to-Output Transfer Function, Duty Ratio-to-Output Transfer Function, Load Current-to-Output Transfer Function.

**Total: 45 Hours**

**Reference(s)**

1. Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition 2017.
2. Fundamentals of Power Electronics with MATLAB, Randall Shaffer, Lakshmi publications . 2nd Edition, 2013,
3. Feedback Control problems using MATLAB and the Control system tool box, Dean Frederick and Joe Cho, 2000, 1st Edition, Cengage learning.
4. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005,1st Edition.
5. 2005,1st Edition.
6. Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley,2021, 1st Edition.
7. Emerging Power Converters for Renewable Energy and Electric Vehicles Modeling, Design,
8. and Control, Md. Rabiul Islam,Md. Rakibuzzaman Shah, Mohd. Hasan Ali, CRC Press,2021, 1st Edition.
9. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals, Second Edition” CRC
10. Press, Taylor & Francis Group, Third Edition 2021.

**21EE015 ELECTRIC VEHICLE DESGN, MECHANICS AND CONTROL**

**3 0 0 3**

**Course Objectives**

- To understand the basics of EV and vehicle mechanics
- To identify the EV architecture and its types
- To find out the various types of energy storage system concepts
- To derive model for batteries and to know the different types of batteries and its charging methods
- To comprehend the control preliminaries for DC-DC converters.

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- d. 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.
- m. PSO1: Design, analyze, and evaluate the performance of Electrical and Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Analyse the internal combustion engine based on vehicle fuel economy, emission control systems
2. Interpret the vehicle mechanics of EV and HEV
3. Analyse the battery pack and battery charging methods for different types of battery
4. Assess the stability of boost converter using bode plot
5. Evaluate the performance of AC motor with vector control and direct torque control.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	-	-	-	-	-	-	1	2	-	2	3	-
2	3	-	3	-	-	-	-	-	1	3	-	2	3	-
3	3	2	-	-	-	-	3	-	1	2	-	2	3	-
4	3	3	2	-	-	-	3	-	1	2	-	2	3	-
5	3	1	-	-	-	-	3	-	1	2	-	2	3	2

**UNIT I** **9 Hours**

**INTERNAL COMBUSTION ENGINES**

IC Engines, BMEP and BSFC, Vehicle Fuel Economy, Emission Control Systems, Treatment of Diesel Exhaust Emissions.

**UNIT II** **9 Hours**

**ELECTRIC VEHICLES AND VEHICLE MECHANICS**

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings- Comparisons of EV with internal combustion Engine vehicles- Fundamentals of vehicle mechanics.

**UNIT III** **9 Hours**

**BATTERY MODELING, TYPES AND CHARGING**

Batteries in Electric & Hybrid Vehicles – Battery Parameters. Types- Lead Acid Battery - Nickel-Cadmium & Nickel-Metal-Hydrate (NiMH) Battery - Li-Ion & Li-Polymer Battery, Zinc-Air Battery, Sodium-Sulphur & Sodium-Metal-Chloride, R&D for Advanced Batteries. Battery- Modelling, Pack Management & Charging, Electric Circuit Models.

**UNIT IV** **9 Hours**

**CONTROL PRELIMINARIES**

Control Design Preliminaries - Transfer Functions – Bode plot analysis for First order and second order systems - Stability - Transient Performance- Power transfer function for boost converter - Gain margin and Phase margin study-open loop mode.

**UNIT V** **9 Hours**

**CONTROL OF AC MACHINES**

Introduction- Reference frame theory, basics-modeling of induction and synchronous machine in various frames-Vector control- Direct torque control.

**Total: 45 Hours**

**Reference(s)**

1. Electric and Hybrid Vehicles, Design Fundamentals, Third Edition, Iqbal Husain, CRC Press, 2021.
2. Power Electronic Converters, Dynamics and Control in Conventional and Renewable Energy Applications, Teuvo Suntio, Tuomas Messo, Joonas Puukko, 1st Edition, Wiley - VCH.
3. Ali Emadi, Mehrdad Ehsani, John M. Miller, "Vehicular Electric Power Systems", Special Indian Edition, Marcel Dekker, Inc 2003, 1st Edition.
4. C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001, 1st Edition.
5. 5Wie Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, John Wiley & Sons, 2017, 2nd Edition.
6. Dynamic Simulation of Electric Machinery using MATLAB, Chee Mun Ong, Prentice Hall, 1997, 1st Edition.
7. Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley, 2021, 1st Edition.

**21EE016 DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM****3 0 0 3****Course Objectives**

- To understand the fundamental concept of charging stations and their standards.
- To learn about the working of power converters in electric vehicle charging stations.
- To find the various electric vehicle charging schemes using renewable energies and storage systems.
- To demonstrate the wireless power transfer technique for electric vehicle charging systems.
- To understand the necessity of PF improvement and design power factor correction circuits.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- 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.
- PSO1: Design, analyze, and evaluate the performance of Electrical and Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Understand the various charging techniques, charging standards and regulations.
- Analyze the working of DC-DC converters used in the EV charging systems.
- Analyze the performance of renewable energy-based charging systems.
- Evaluate the working principle of wireless power transfer in EV charging systems.
- Evaluate the performance of power converters by boosting the power factor.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	3	-	-	2	2	-	3	-	3	3	--
2	3	3	3	3	-	-	2	2	-	3	-	3	3	3
3	3	-	-	-	-	-	-	-	-	-	-	-	3	3
4	3	3	3	3	-	-	2	2	-	2	-	1	3	3
5	3	-	-	-	-	-	-	-	-	-	-	-	3	3

**UNIT I**

**9 Hours**

**CHARGING STATIONS AND STANDARDS**

Introduction-Charging technologies- Conductive charging, EV charging infrastructure, International standards and regulations - Inductive charging, need for inductive charging of EV, Modes and operating principle, Static and dynamic charging, Bidirectional power flow, International standards and regulations

**UNIT II**

**9 Hours**

**POWER ELECTRONICS FOR EV CHARGING**

Layouts of EV Battery Charging Systems-AC charging-DC charging systems- Power Electronic Converters for EV Battery Charging- AC–DC converter with boost PFC circuit, with bridge and without bridge circuit - Bidirectional DC–DC Converters- Non-isolated DC– DC bidirectional converter topologies- Half-bridge bidirectional converter.

**UNIT III**

**9 Hours**

**EV CHARGING USING RENEWABLE AND STORAGE SYSTEMS**

Introduction- - EV charger topologies , EV charging/discharging strategies - Integration of EV charging-home solar PV system , Operation modes of EVC-HSP system , Control strategy of EVC- HSP system - fast-charging infrastructure with solar PV and energy storage.

**UNIT IV**

**9 Hours**

**WIRELESS POWER TRANSFER**

Introduction - Inductive, Magnetic Resonance, Capacitive types. Wireless Chargers for Electric Vehicles - Types of Electric Vehicles - Battery Technology in EVs -Charging Modes in EVs - Benefits of WPT. - WPT Operation Modes - Standards for EV Wireless Chargers, SAE J2954, IEC 61980. ISO 19363

**UNIT V**

**9 Hours**

**POWER FACTOR CORRECTION IN CHARGING SYSTEM**

Need for power factor correction- Boost Converter for Power Factor Correction, Sizing the Boost Inductor, Average Currents in the Rectifier and calculation of power losses-

**Total: 45 Hours**

**Reference(s)**

1. Mobile Electric Vehicles Online Charging and Discharging, Miao Wang Ran Zhang Xuemin (Sherman) Shen, Springer 2016, 1st Edition.
2. Alicia Triviño-Cabrera, José M. González-González, José A. Aguado, Wireless Power Transferor Electric Vehicles: Foundations and Design Approach, Springer Publisher 1st Edition. 2020.
3. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, Electric Vehicles Modern Technologies and Trends. Springer Publisher 1st Edition, 2021.
4. Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control, management and grid integration, Rajiv Singh, Sanjeevikumar Padmanaban, Sanjeet Dwivedi, Marta Molinas and Frede Blaabjerg, IET 2021, 1st Edition.
5. Electric and Hybrid Electric Vehicles, James D Halderman, Pearson, 2022, 1st Edition.
6. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005.

**21EE017 GRID INTEGRATION OF ELECTRIC VEHICLES**

**3 0 0 3**

**Course Objectives**

- To understand the Vehicle-to-Grid (V2G) technology in the context of electric vehicle integration with the power grid.
- To understand the grid stability, energy efficiency, and economic advantages of V2G
- To identify and examine the challenges and barriers faced in the successful implementation of V2G.
- To Understand the impact of Electric Vehicles (EVs) and V2G technology on the smart grid and renewable energy systems.
- To comprehend the principles and strategies for effectively integrating and managing Electric Vehicles (EVs) within the existing power grid infrastructure.

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- d. 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.
- m. PSO1: Design, analyze, and evaluate the performance of Electrical and Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Assess V2G potential impact on the power grid and energy management.
2. Analyse the benefits of V2G integration, propose strategies for enhancing sustainable energy systems
3. Analyse the key challenges hindering V2G adoption, propose potential solutions for effective grid integration
4. Assess the influence of EVs and V2G on grid stability for optimizing their synergistic effects.
5. Design and implement grid integration solutions of EVs while maintaining grid stability and efficiency.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	-	-	-	-	-	2	1	-	2	-	-	3	3
2	3	3	-	-	3	-	2	1	-	2	-	-	3	-
3	3	-	-	-	-	-	2	1	-	2	-	-	3	-
4	3	-	-	-	-	-	2	1	-	2	-	-	3	-
5	3	-	-	-	-	-	2	1	-	2	-	-	3	-

**UNIT I**

**9 Hours**

**DEFINITION, And STATUS Of V2G**

Defining Vehicle to Grid (V2G) - History and Development of V2G. Incorporating V2G to the EV, Auditing and Metering, V2G in Practice, V2G - Power Markets and Applications . Electricity Markets and V2G Suitability , Long-Term Storage, Renewable Energy, and Other Grid Applications , Beyond the Grid: Other Concepts Related to V2G

**UNIT II**

**9 Hours**

**BENEFITS OF V2G**

Benefits of V2G, Technical Benefits: Storage Superiority and Grid Efficiency, Economic Benefits: EV Owners and Societal Savings, Environment and Health Benefits: Sustainability in Electricity and Transport, Other Benefits.

**UNIT III**

**9 Hours**

**CHALLENGES TO V2G**

Battery Limitations and Vehicle Considerations- Policy and Regulatory Hurdles for V2G Adoption- Ensuring Data Security and Privacy in V2G- Overcoming User Resistance to V2G Participation- Planning for V2G Integration in the Power Grid- Assessing Environmental Impacts of V2G Deployment

**UNIT IV**

**9 Hours**

**IMPACT OF EV AND V2G ON THE SMART GRID AND RENEWABLE ENERGY SYSTEMS**

EV Charging Infrastructure and Grid Integration - Types of Electric Vehicles - Motor Vehicle Ownership and EV Migration - Impact of Estimated EVs on Electrical Network - Impact on Drivers and the Smart Grid - Standardization and Plug-and-Play - IEC 61850 Communication Standard and IEC 61850-7-420 Extension.

**UNIT V**

**9 Hours**

**GRID INTEGRATION AND MANAGEMENT OF EVS**

Importance of Grid Integration - Machine to Machine (M2M) in distributed energy management systems - M2M communication for EVs - M2M communication architecture (3GPP) - Electric vehicle data logging - Scalability of electric vehicles -M2M communication with scheduling.

**Total: 45 Hours**

**Reference(s)**

1. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press 2017, 1st Edition.
2. Plug In Electric Vehicles in Smart Grids, Charging Strategies, Sumedha Rajakaruna , Farhad Shahnian and Arindam Ghosh, Springer, 2015, 1st Edition.
3. ICT for Electric Vehicle Integration with the Smart Grid, Nand Kishor 1; Jesus Fraile-Ardanuy, IET 2020, 1st Edition.
4. Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid, Junwei Lu and Jahangir Hossain, IET 2015, 1st Edition.
5. Lance Noel · Gerardo Zarazua de Rubens Johannes Kester · Benjamin K. Sovacool, Vehicle- to-Grid A Sociotechnical Transition Beyond Electric Mobility, 2019, 1st Edition.

**21EE018 INTELLIGENT CONTROL OF ELECTRIC VEHICLES****3 0 0 3****Course Objectives**

- To understand the mathematical model of a BLDC motor and its characteristics
- To understand the different control schemes for BLDC motor
- To understand the need of fuzzy in control of electric vehicles
- To understand the fundamentals of FPGA and VHDL
- To understand the fuzzy logic control of BLDC motor .

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- d. 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.
- m. PSO1: Design, analyze, and evaluate the performance of Electrical and Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Interpret the mathematical model of a BLDC motor and to discuss about its characteristics.
2. Represent the various speed control methods for controlling the speed of BLDC motor.
3. Infer the concept of fuzzy system
4. Understand the basics of VHDL & FPGA applied to control of EVs.
5. Design and implement of fuzzy logic control scheme for BLDC motor using FPGA in real time.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	-	-	-	-	-	-	-	-	-	1	1
2	1	2	-	-	-	-	-	-	-	-	-	-	1	1
3	2		2	-	-	-	-	-	-	-	-	-	3	1
4	2	1	2	-	-	-	-	-	-	-	-	-	3	1
5	2	1	3	-	-	-	-	-	-	-	-	-	2	1

**UNIT I**

**9 Hours**

**MATHEMATICAL MODEL AND CHARACTERISTICS ANALYSIS OF THE BLDC MOTOR**

Structure and Drive Modes - Basic Structure, General Design Method, Drive Modes. Differential Equations, Transfer Functions, State-Space Equations., Starting Characteristics, Steady-State Operation, Dynamic Characteristics, Load Matching Commutation Transients

**UNIT II**

**9 Hours**

**SPEED CONTROL FOR ELECTRIC DRIVES**

Introduction -PID Control Principle, Anti windup Controller, Intelligent Controller. Vector Control. Control applied to BLDC motor.

**UNIT III**

**9 Hours**

**FUZZY LOGIC**

Membership functions, Fuzzification, Defuzzification, Fuzzy Arithmetic and Fuzzy Measures, Fuzzy Rule Base and Approximate Reasoning, Fuzzy Propositions, Rule Formation and Decomposition, Aggregation, Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert System, Fuzzy Decision Making.

**UNIT IV**

**9 Hours**

**FPGA AND VHDL BASICS**

Introduction – FPGA Architecture-Advantages-Review of FPGA family processors- Spartan 3, Spartan 6 and Spartan 7. VHDL Basics- Fundamentals-Instruction set-data type-conditional statements- programs like arithmetic, sorting, PWM generation, Speed detection.

**UNIT V**

**9 Hours**

**REAL TIME IMPLEMENTATION**

Inverter design, identifying rotor position via hall effect sensors, open loop and fuzzy logic control of 48 V BLDC motor using FPGA.

**Total: 45 Hours**

**Reference(s)**

1. John G. Hayes, G. Abas Goodarzi, 'Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles' Wiley 1<sup>st</sup> Edition 2018.
2. Jayaram Bhasker, 'VHDL Primer', A (3rd Edition), Prentice Hall, 1<sup>st</sup> Edition 2015.
3. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Third Edition" CRC Press, Taylor & Francis Group, 2021, 1<sup>st</sup> Edition.
3. Chang-liang, Permanent Magnet Brushless DC Motor Drives and Controls, Xia Wiley 2012, 1<sup>st</sup> Edition.
5. M.N. Cirstea, A. Dinu, J.G. Khor, M. McCormick, Neural and Fuzzy Logic Control of Drives and Power Systems, Newnes publications, 1st Edition, 2002.
6. Wei Liu, 'Hybrid Electric Vehicle System Modelling and Control', Wiley 2017, 2<sup>nd</sup> Edition.

**Course Objectives**

- To provide solar radiation and its measurement techniques
- To understand the overview of solar pv cell and its mathematical model.
- To attain a broad comprehension on solar photovoltaic standalone and grid connected system
- To understand the operations of solar thermal energy conversion system.
- To understand the applications of solar pv and solar thermal systems

**Programme Outcomes (POs)**

- a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- d. 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.
- e. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- m. PSO1: Design, analyze, and evaluate the performance of Electrical and Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Apply the various instruments for measuring solar radiation.
2. Analyse the I-V characteristics of Solar PV System and conversion efficiency
3. Design a converter control topology for standalone and grid connected PV systems.
4. Analyse the different types of solar thermal energy collectors.
5. Apply a suitable Solar PV or thermal systems for various domestic and industrial applications.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	-	-	-	-	-	-	-	-	-	-	1	-
2	2	2	-	3	1	-	-	-	-	-	-	-	3	-
3	2	2	3	1	1	-	-	-	-	-	-	-	3	-
4	2	-	2	-	1	-	-	-	-	-	-	-	2	-
5	3	-	2	-	1	-	-	-	-	-	-	-	-	2

**UNIT I** **7 Hours**

**SOLAR RADIATION AND MEASUREMENT**

Electromagnetic spectrum-Solar angles-Sun path diagrams-Solar insolation- -Radiation absorption, scattering -Measurement of radiation-Pyranometer-Pyrheliometer-Sunshine recorder.

**UNIT II** **10 Hours**

**SOLAR PV CELL**

Formation of a PN – junction - Space charge and internal field - Quasi - Fermi levels - The Shockley diode equation - Structure of a solar cell - The solar cell equation - I-V characteristics - Fill factor - Crystalline silicon solar cells - Thin film solar cells - PV Cell Interconnection and Module Fabrication - PV Modules and arrays -Conditions for maximum power Transfer-Conversion efficiency- Basics of Load Estimation.

**UNIT III** **8 Hours**

**STAND-ALONE AND GRID CONNECTED PV SYSTEMS**

Grid interconnection standards- - Inverter control topologies for standalone and grid connected systems-Feasible operating region of inverter for grid connected system -Real time issues in grid connected systems- Maximum Power Point Tracking algorithms.

**UNIT IV** **10 Hours**

**SOLAR THERMAL ENERGY CONVERSION**

Solar thermal energy- Solar flat plate collector, solar evacuated tube collector -Pool and Air Collectors Construction -Function - Solar heating and cooling system - Real time issues in solar thermal systems-Comparison of solar thermal and Solar PV systems.

**UNIT V** **10 Hours**

**APPLICATIONS OF SOLAR PV AND SOLAR THERMAL SYSTEMS**

Solar PV power plant - Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping -Solar thermal electric power plant -solar thermal applications: heating, cooling, desalination, drying, cooking, Solar Ponds.

**FOR FURTHER READING**

Indian and International Energy Policies-Recent trends in solar thermal and Solar PV systems - Limitations of solar thermal and PV systems.

**Total: 45 Hours**

**Reference(s)**

1. CS Solanki, Solar Photovoltaics, Fundamentals, Technologies and Applications, 3rd edition, PHI Learning Pvt. Ltd., 2015.
2. Martin A. Green, Solar Cells Operating Principles, Technology, and System Applications PrenticeHall, 2008.
3. H.P. Garg and J. Prakash., Solar Energy, Fundamentals & Applications, Tata McGraw Hill book Co, New Delhi, 2017.
4. S.P. Sukhatme, J.K. Nayak, Solar Energy-Principle of thermal storage and collection, Tata McGraw Hill book Co, 3<sup>rd</sup> edition New Delhi, 2011.
5. G.N.Tiwari, Solar Energy-Fundamentals, Design, Modeling and Applications, Narosha Publishing House Ltd., 2013.
6. Amine Allouhi et al. Up-to-date literature review on Solar PV systems: Technology progress, market status and R&D, Journal of Cleaner Production (2022)

**21EE020 WIND POWER TECHNOLOGY****3 0 0 3****Course Objectives**

- To understand the wind power scenario, characteristics and classifications of WECS.
- To learn the design and control principles of Wind turbine.
- To understand the concepts of fixed speed and variable speed, wind energy conversion systems.
- To understand the operations of various generators used in WECS.
- To analyze the grid integration issues.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- PSO1: Design, analyze, and evaluate the performance of Electrical and Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Analyze the performance of WECS and select a suitable site.
- Analyze the control mechanism for wind turbine.
- Analyze the different types of generator for fixed speed wind turbine systems.
- Apply the characteristics of generators for variable speed constant frequency systems.
- Analyze the interconnection requirements of grid connected systems.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	-	-	-	1	-	-	-	-	-	2	3
2	3	2	3	-	-	-	-	-	-	-	-	-	3	3
3	2	3	3	-	-	-	-	-	-	-	-	-	3	3
4	3	2	3	-	-	-	-	-	-	-	-	-	3	3
5	2	3	2	-	-	-	1	-	-	-	-	-	3	3

**UNIT I** **9 Hours**

**INTRODUCTION**

Wind source -Characteristics of Wind Energy-Wind Energy Conversion System (WECS) siting - Classification- Types of Towers -Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-Aerodynamics of Wind turbine- offshore Wind Turbine.

**UNIT II** **9 Hours**

**WIND TURBINES**

Terminologies-Types of Wind Power Plants-HAWT and VAWT -Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations-Tip speed ratio-Number of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control- stall control-Schemes for maximum power extraction.

**UNIT III** **9 Hours**

**FIXED SPEED SYSTEMS**

Generating Systems- Constant speed constant frequency systems -Choice of Generators-Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model of wind turbine rotor - Drive Train model.

**UNIT IV** **9 Hours**

**VARIABLE SPEED SYSTEMS**

Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modelling - Variable speed variable frequency schemes.

**UNIT V** **9 Hours**

**GRID CONNECTED SYSTEMS**

Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, Harmonics and Power Quality-Wind Turbine as a Discrete Generator-Islanding.

**FOR FURTHER READING**

Hybrid Energy systems- wind - photovoltaic systems-wind- diesel hybrid systems-diesel generator and photovoltaic systems.

**Total: 45 Hours**

**Reference(s)**

1. Earnest Joshua, "Wind Power Technology", PHI Learning, New Delhi, 2019, ISBN: 978-8120351660.
2. S.N.Bhadra, D.Kastha, S.Banerjee, "Wind Electrical Systems", Oxford University Press,2010.
3. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2015.
4. Ahmad Hemami, "Wind Power Technology", Cengage Learning Series in Renewable Energy, 2012.
5. N. Jenkins, "Wind Energy Technology", John Wiley & Sons,2021.
6. Siegfried Heier, "Grid Integration of WECS", John Wiley & Sons Ltd, 2014.

**21EE021 FUEL CELL SYSTEMS****3 0 0 3****Course Objectives**

- To Understand the principles of fuel cell technology
- To understand the concept of fuel cell system components
- To differentiate and apply the working of different fuels cells.
- To analyse fuel cell system design and integration.
- To analyse the applications of fuel cell systems.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
  - Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - 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.
  - 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.
- n. PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Apply the concepts of fuel cell basic components.
2. Analyse the working of fuel cell under different parameter constraints.
3. Analyse the benefits of fuel cells applications.
4. Analyse the role of Safety and Environmental Considerations.
5. Design solutions for optimised fuel cell systems.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	2	-	-	-	-	-	-	-	-	-	2
2	3	2	2	2	-	-	-	-	-	-	-	-	-	2
3	3	2	2	2	-	-	-	-	-	-	-	-	-	2
4	3	2	2	2	-	-	-	-	-	-	-	-	-	2
5	3	2	2	2	-	-	-	-	-	-	-	-	-	2

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

Types of fuel cells: proton exchange membrane (PEM), solid oxide (SOFC), molten carbonate (MCFC), and phosphoric acid (PAFC) fuel cells-Working principles of fuel cells-Electrochemical reactions in fuel cells-Advantages and challenges of fuel cell technology

**UNIT II****9 Hours****FUEL CELL COMPONENTS AND MATERIALS**

Electrodes and catalysts: types, characteristics, and selection criteria-Membranes and electrolytes: properties and considerations-Bipolar plates and current collectors-Gas diffusion layers and flow fields-Materials selection for fuel cell components-Durability and performance considerations

**UNIT III**

**9 Hours**

**FUEL CELL SYSTEMS AND DESIGN**

System configurations: standalone, grid-connected, and hybrid systems-Balance of plant (BOP) components: compressors, humidifiers, heat exchangers, pumps, and control systems-System efficiency and optimization strategies-System integration and control-Safety considerations in fuel cell system design

**UNIT IV**

**9 Hours**

**FUEL CELL APPLICATIONS**

Transportation applications: automotive, buses, and trains-Portable and off-grid power applications-Residential and commercial stationary power generation-Industrial and remote power systems-Emerging applications and market trends

**UNIT V**

**9 Hours**

**FUEL CELL PERFORMANCE, TESTING, AND CHARACTERIZATION**

Fuel cell performance metrics: voltage-current characteristics, power density, and efficiency-Testing methodologies and protocols-Diagnosis and troubleshooting of fuel cell systems-Performance modelling and simulation-Lifetime and degradation analysis

**FOR FURTHER READING**

Fuel Cell Materials, Fuel Cell Stack Design, Fuel Cell Electrochemistry - Fuel Cell Degradation and Durability

**Total: 45 Hours**

**Reference(s)**

1. Ryan O'Hayre, Suk-Won Cha, Whitney Colella, and Fritz B. Prinz, "Fuel Cell Fundamentals", PHI Learning, New Delhi, 2016
2. James Larminie and Andrew Dicks, "Fuel Cell Systems Explained", Latest edition: 2003.
3. Nigel Sammes and Ruud van Berkel, "Fuel Cell Technology: Reaching Towards Commercialization", (Latest edition: 2006).
4. Matthew M. Mench and Kwang J. Kim, "Fuel Cell Engines", (Latest edition: 2008).
5. Ludwig Jörissen and Detlef Stolten, "Fuel Cells: Principles, Design, and Analysis", (Latest edition: 2013)

**21EE022 RENEWABLE ENERGY SYSTEMS INSTALLATIONS  
AND MAINTENANCE**

**3 0 0 3**

**Course Objectives**

- To Understand the fundamental principles and components of solar energy systems
- To understand site assessment and design considerations
- To understand the electrical wiring and commissioning of solar energy systems
- To apply the concepts and methods for maintenance and troubleshooting
- To apply the principles and applications of off-grid and grid-tied solar energy systems.

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- n. PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Apply the fundamental principles and components of solar energy systems
2. Assess the Design and plan for the solar energy systems
3. Design, installation and commissioning solar energy systems.
4. Analyse performance and troubleshooting techniques of solar energy systems.
5. Analyse performance of an off grid and grid tied solar energy systems

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	-	-	-	2	-	-	-	-	-	-	2
2	3	2	3	-	-	-	2	-	-	-	-	-	-	2
3	2	3	3	-	-	-	2	-	-	-	-	-	-	2
4	3	2	3	-	-	-	2	-	-	-	-	-	-	2
5	2	3	2	-	-	-	2	-	-	-	-	-	-	2

**UNIT I**

**9 Hours**

**INTRODUCTION**

Overview of solar energy and its importance Basic principles of solar energy conversions - Types of solar energy systems: photovoltaic (PV) systems and solar thermal systems - Components of a solar energy system: solar panels, inverters, batteries, charge controllers

**UNIT II**

**9 Hours**

**DESIGNING SOLAR ENERGY SYSTEMS**

Site assessment and analysis for solar energy systems - Load estimation and energy consumption analysis - Sizing of solar energy systems based on energy needs - Placement and orientation of solar panels for optimal performance - Electrical design considerations: wiring, grounding, and safety.

**UNIT III**

**9 Hours**

**SOLAR ENERGY SYSTEM INSTALLATION**

Preparing the site for installation: permits, regulations, and safety measures - Mounting and securing solar panels - Electrical wiring and connections - Installation of inverters, batteries, charge controllers, and other system components - Testing and commissioning the solar energy system

**UNIT IV**

**9 Hours**

**MAINTENANCE AND TROUBLESHOOTING**

Regular maintenance practices for solar energy systems - Cleaning and inspection of solar panels - Monitoring and performance analysis - Identifying and addressing common issues and troubleshooting techniques - Safety precautions during maintenance activities.

**UNIT V**

**9 Hours**

**OFF-GRID AND GRID-TIED SYSTEMS**

Off-grid solar energy systems: design and installation considerations - Battery storage systems: types, sizing, and maintenance - Grid-tied solar energy systems: connecting to the electrical grid - Net metering and feed-in tariffs - Backup power options and emergency preparedness

**FOR FURTHER READING**

Photovoltaic systems- Solar PV Engineering and Installation- Solar Power Plant Design

**Total: 45 Hours**

**Reference(s)**

1. Muhammad H., "Photovoltaic Systems: Analysis and Design", Year: 2018
2. Michael Boxwell, "Solar Electricity Handbook: A Simple, Practical Guide to Solar Energy",2020
3. Sean White "Solar PV Engineering and Installation: Preparation for the NABCEP PV Installation Professional Certification",2015.
4. Chetan Singh Solanki "Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers, and Engineers",2012
5. Majid Ghassemi & Robert Foster, "Solar Energy: Renewable Energy and the Environment",2018.

**21EE023 ENERGY STORAGE SYSTEMS****3 0 0 3****Course Objectives**

- Understand the significance of energy storage schemes.
- Understand the working of two types of mechanical energy storage systems
- Understand the concepts of various models of batteries
- Understand the performance of passive energy storage elements.
- Understand the principles of different methods of thermal energy storage schemes

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- PSO1: Design, analyze, and evaluate the performance of Electrical and Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Justify the significance of energy storage in current scenario.
- Apply the concepts of mechanical energy in storage schemes
- Compare the working methods of various electrochemical batteries.
- Apply the principle of Electromagnetism for energy storage.
- Analyze the various methods of thermal energy storage systems.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	-	-	-	1	-	-	-	-	-	2	3
2	3	2	3	-	-	-	-	-	-	-	-	-	3	3
3	2	3	3	-	-	-	-	-	-	-	-	-	3	3
4	3	2	3	-	-	-	-	-	-	-	-	-	3	3
5	2	3	2	-	-	-	1	-	-	-	-	-	3	3

**UNIT I****8 Hours****MODES OF STORAGE**

Need and importance of Energy storage, Periodic Storage, Modes of Storage: Thermo-chemical energy storage, Energy Storage in Organic Fuels, Hydrogen Storage.

**UNIT II** **9 Hours**

**MECHANICAL ENERGY STORAGE**

Introduction - Potential Energy Storage - Energy Storage in Pressurized Gas - Pumped-Hydro Storage - Kinetic Energy in Mechanical Systems - Linear and Rotational Kinetic Energy - Internal Structural Energy Storage, Applications

**UNIT III** **10 Hours**

**ELECTROCHEMICAL ENERGY STORAGE SYSTEMS**

Fundamental concepts - Reaction Mechanisms in Electrochemical Cells - Practical Parameters, Equivalent Circuit, Types of batteries: Primary, Secondary, Lithium, Solid-state and molten solvent, lead acid, Nickel Cadmium Batteries; Zinc Manganese dioxide, Applications.

**UNIT IV** **9 Hours**

**ELECTROMAGNETIC ENERGY STORAGE SYSTEMS**

Superconducting Magnet Energy Storage (SMES) systems, Energy in a Material in a Magnetic Field, Superconductive Materials, Super capacitor: Electrochemical Double Layer Capacitor (EDLC): principle of working, structure, performance and applications

**UNIT V** **9 Hours**

**THERMAL ENERGY STORAGE**

Basic Principles - Benefits - Methods - Sensible Thermal Energy Storage (TES)- Latent TES - Cold TES - Seasonal TES - Thermal Energy Savings - Environmental Impacts - Applications.

**FURTHER READING**

Ocean wave energy - conversion, principle, power plants, tidal energy conversion, Scope and development

**Total: 45 Hours**

**Reference(s)**

1. S.R. Khalid, " Energy Storage Systems: Operation and Control", CRC Press, 1st Edition, 2020.
2. Bengt Sundén and Mohammad Reza Ghalambor, "Handbook of Energy Storage: Types, Technologies and Applications", Springer, 1st Edition, 2019.
3. Huggins, Robert A., Energy Storage: Fundamentals, Materials and Applications, Second Edition, Springer US, 2015.
4. Ibrahim Dincer, Mark A. Rosen, Thermal Energy Storage Systems and Applications, 2nd Edition, Wiley, 2011.
5. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, First, Wiley publications, 2012.

**21EE024 GRID INTEGRATION OF RENEWABLE SOURCES****3 0 0 3****Course Objectives**

- To understand the operation of grid interconnected renewable energy systems.
- To identify the grid integration issues.
- To understand the grid integration of PV system.
- To understand the grid integration of wind system.
- To understand the Integration of alternate sources of energy.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.
- 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.
- PSO1: Design, analyze, and evaluate the performance of Electrical and Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Understand the challenges and opportunities for renewable generation in both large interconnected grid and micro grid settings.
- Identify the requirements for grid interconnection and its impact with NCE sources.
- Analysis the current techniques of PV interconnections with power system.
- Analysis the current techniques of wind interconnections with power system.
- Analysis the principles, power and limitations of complex power networks incorporating distributed generation and storage.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	-	-	-	-	-	-	-	-	-	-	2	2
2	2	3	-	-	-	-	-	-	-	-	-	-	2	2
3	2	2	2	3	-	-	-	-	-	-	-	-	3	2
4	2	2	3	3	-	-	-	-	-	-	-	-	3	3
5	2	3	3	3	-	-	-	-	-	-	-	-	3	3

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

Introduction to renewable energy systems, environmental aspects of electric energy conversion, impacts of renewable energy penetration to grid. Grid Codes in India and other countries. Basic power electronic converters for renewable energy integration to grid - Qualitative analysis - Grid Interactive Inverters-matrix converters.

**UNIT II** **9 Hours**  
**IMPACT OF GRID INTEGRATION**

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 III** **9 Hours**  
**GRID INTEGRATION OF PV SYSTEMS**

Grid-Connected PV Power Systems - Inverter Control Algorithms - Synchronous Reference Frame–Based Current Controller - Digital PI-Based Current Controller - Adaptive Notch Filter-Based Grid Synchronization - Modeling, Simulation, and Hardware Implementation of Controllers

**UNIT IV** **9 Hours**  
**GRID INTEGRATION OF WIND SYSTEMS**

Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modeling issue.

**UNIT V** **9 Hours**  
**INTEGRATION OF ALTERNATE SOURCES OF ENERGY**

Introduction, principles of power injection: converting technologies, power flow; instantaneous active and reactive power control approach; integrating multiple renewable energy sources; DC link integration; AC link integration; HFAC link integration; islanding and interconnection

**Total: 45 Hours**

**Reference(s)**

1. Marco H. Balderas, ‘Renewable Energy Grid Integration, Nova Science Publishers, New York, 2009.
2. Majid Jamil, M. Rizwan, D.P.Kothari, ‘Grid integration of solar photovoltaic systems’, CRC Press, New York, 2017.
3. B. Fox, D. Flynn L. Bryans, N. Jenkins, M. O Malley, R. Watson and D. Milborrow, ‘Wind Power Integration connection and system operational aspect, 1<sup>st</sup> Edition, IET Power and Energy Series 50, 2007.
4. H. Siegfried and R. Waddington, “Grid integration of wind energy conversion systems” John Wiley and Sons Ltd., 2006.
5. Felix A. Farret and M. Godoy Simoes, ‘Integration of Alternative sources of Energy’, 1<sup>st</sup> Edition, IEEE Press – Wiley-Interscience publication, 2006.

**Course Objectives**

- To understand the definitions for illumination and types of lamps.
- To Maintain different types of electrical utilities and systems.
- To look over the Electric drives for traction.
- To understand the Electric drives for elevators.
- To analyze the tariff and power factor improvement for all types of supplies.

**Programme Outcomes (POs)**

- a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
- b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- d. 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.
- g. 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.
- l. 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.
- m.PSO1: Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n.PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Analyze the functioning of different types of lamps, laws and fittings.
2. Analyze different electric heating methods and different welding equipment.
3. Analyze About different types of electric drives and elevators.
4. Apply the different electric traction systems and speed calculations.
5. Apply the tariffs for various schemes and analyze equipment for power factor improvement.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	3	3	3	2	-	-	2	-	-	-	1	-	3	2	-
2	3	3	3	2	-	-	2	-	-	-	1	-	3	1	-
3	3	3	3	2	-	-	3	-	-	-	1	-	3	3	-
4	3	3	3	2	-	-	3	-	-	-	1	-	3	3	-
5	3	3	3	2	-	-	1	-	-	-	1	-	2	1	-

### **Unit-I**

#### **Illumination**

**9 Hours**

Illumination terminologies - Laws of Illumination – Inverse square law and Lambert’s cosine law - Various types of lamps - LED lamps - Various lighting schemes: features and application - Domestic and industrial lamp fittings, Electronic ballast.

### **Unit II**

#### **Electric Heating and welding systems**

**9 hours**

Concept of electrical heating - classification of electric heating - Induction heating - Dielectric heating - Types of welding systems - Arc welding - Supply requirements; AC welding machines - welding transformer, safety precautions

### **Unit III**

#### **Electric Drives and Elevators**

**9 Hours**

Electric Drives -Transmission of mechanical power - Bearing - Size and rating of motor, Definition of standard rating as per IS - Load cycles - Load Equalization - Braking – Elevators - Factors on which shape and size of car depends - Bombay Lift Act 1939. (Latest Amendment).

### **Unit IV**

#### **Electric Traction**

**9 Hours**

Requirements of an ideal traction system - different types of traction system used in India - Traction mechanics - Traction motors - Definition of average and schedule speed, factors affecting schedule speed - Speed-time curve - Current collecting System: - Pantographs.

### **Unit V**

#### **Tariff and Power Factor Improvement**

**9 Hours**

Tariff: Desirable characteristics, types - Power factor - Power factor improvement using; static capacitor-most economical power factor, location of power factor improvement - Devices from consumer and electrical supply company point of view.

### **Reference Book(s)**

1. Pratap H, “Art and Science of Utilization of Electrical Energy” ,Dhanpat Rai & Sons, New Delhi, 2017.
2. Gupta J B “Utilization of Electric Power and Electric Traction”, S. K. Kataria & Sons, New Delhi, 2016.
3. Garg “Utilization of Electric Power and Electric Traction”, G. C. Khanna Publishers, New Delhi, 2016,
4. Upadhyay J, Mahendra S N, “Electric Traction”, Allied Publisher Ltd., New Delhi, Latest edition .
5. Dubey G, “Fundamentals of Electrical Drives”,G. K. Narosa Publishing House. New Delhi, Latest edition.
6. Mehta V K, “Principles of Power system, S.Chand, New Delhi, Latest edition
7. Sivanagaraju S, Balasubba Reddy M ,Srilatha B “Generation and Utilization of Electrical Energy”, Pearson Education, New Delhi, 2016.
8. Partab H “Modern Electric Traction”, Dhanpat Rai & Sons, New Delhi, 2016.

**21EE032 INDUSTRIAL ELECTRONICS**

**3 0 0 3**

**Course Objective**

- To study about the physical phenomena of different types of sensors.
- To understand about the measuring principal of MEMS devices and technologies.
- To understand about the MEMS devices and technologies and applications.
- To study about the role of FPGA in industrial applications.

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- d. 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.
- m. PSO1: Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Explain the various Fundamental physical phenomena of sensors.
2. Explain the various technological advancement of sensors.
3. Understand the fundamentals of MEMS technologies and its application in industrial devices.
4. Explain and analyse the types and working principles of micro sensors
5. Analyse the role of FPGA in reconfigurable systems.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO1
1	2	2	2	2	-	-	-	-	-	-	-	-	1	2
2	2	3	2	2	-	-	-	-	-	-	-	-	2	2
3	2	3	2	2	-	-	-	-	-	-	-	-	2	2
4	2	2	3	2	-	-	-	-	-	-	-	-	1	2
5	2	2	2	3	-	-	-	-	-	-	-	-	2	2

**UNIT I**

**9 Hours**

**FUNDAMENTALS OF SENSORS AND TRANSDUCERS**

Performance terminology, static and dynamic characteristics of transducers, classification of sensors and transducers, signal processing and signal conditioning. Operational amplifiers, filters, protection devices, analog to digital converter, digital to analog converter.

**UNIT II**

**9 Hours**

**ADVANCED SENSOR TECHNOLOGIES**

Laser production, characteristics of lasers, types of laser sensors, bar code sensors, benefits of bar coding,

transponder, RFID (Radio Frequency Identification), electro-magnetic identifier, optical encoders, colour sensors, sensing principles, colour theory, unit colour measurement, colour comparator, colour sensing algorithm, fuzzy logic colour sensor. fuzzy logic for opt-electronic colour sensor in manufacturing.

### **UNIT III**

**9 Hours**

#### **MEMS TECHNOLOGIES AND APPLICATIONS**

Introduction to Microsystems and microelectronics - Applications of micro system in automotive - bio medical - aerospace - telecommunication industries. Trimmer's scaling vector and scaling laws, Materials for MEMS-Deposition - Etching-Molding.

### **UNIT IV**

**9 Hours**

#### **MICRO SENSORS**

Microsensors - Types of micro sensors - Micro accelerometer, Pressure sensors and thermal sensors. Micro actuation techniques - piezoelectric crystals - Shape memory alloys - bimetallics - conductive polymers. Micro motors - micro grippers - Microfluidic devices - Micro pumps - micro valves - valve less micro pumps.

### **UNIT V**

**9 Hours**

#### **FPGAS AND RECONFIGURABLE SYSTEMS**

Introduction-advanced Hardware resources in FPGAs-Software tools for FPGAs-role of FPGAs in reconfigurable Systems-applications.

#### **FOR FURTHER READING**

Continuous time Signals-Time Domain analysis of Continuous time signals-Frequency Domain analysis of Continuous time signals-Signal Processors-Discrete time (Digital) Filters.

**Total: 45 Hours**

#### **Reference(s)**

1. Maloney, Timothy, "Modern Industrial Electronics", Upper Saddle River: Prentice Hall. 2015.
2. A.K.Sawhney and P.Sawhney, "A Course on Mechanical Measurement Instrumentation and Control", Dhanpat Rai and Co, New Delhi, 2011
3. Tai Ran Hsu, "MEMS and Micro Systems Design and Manufacture", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
4. Rehg, James, A., Sartori, Glenn," Industrial Electronics", Upper Saddle River: Prentice Hall. 2016.
5. G.K.Mithal, "IndustrialElectronics",Khanna Publishers,Delhi, 2016.

**2EE033 ILLUMINATION ENGINEERING**

**3 0 0 3**

**Course Objectives**

- To impart basic knowledge on Illumination.
- To understand the types of sources and accessories used in lighting.
- To understand the measurement techniques of illumination and its parameters.
- To illustrate the design procedures applicable for interior lighting.
- To illustrate the design procedures applicable for exterior lighting.

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- m. PSO1: Modeling, design and Analysis of Electrical and Electronic Systems using design principles and software tools
- n. PSO2: Develop electrical machineries/Appliances for various Domestic and industrialneeds

**Course Outcomes (COs)**

1. Explain the basic concepts of lighting.
2. Select the lighting source and its control technique based on the requirement.
3. Analyse the various parameters of illumination and their measuring techniques.
4. Apply the lighting procedure for designing exterior environments.
5. Apply the lighting procedure for designing interior environments.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
1	3	-	-	-	-	-	-	-	-	-	-	-	1	
2	3	-	-	-	-	-	-	-	-	-	-	-	-	3
3	2	3	-	-	-	-	-	-	-	-	-	-	1	-
4	2	-	3	-	-	-	-	-	-	-	-	-	3	2
5	2	-	3	-	-	-	-	-	-	-	-	-	3	2

**UNIT I**

**7 Hours**

**INTRODUCTION**

Light and Lighting, Basic Concepts and Units, Photometry and Measurement, Quantity and Quality of Lighting. Factors affecting lighting, artificial lighting, Lighting scheme.

**UNIT II**

**8 Hours**

**ACCESSORIES**

Light sources: Daylight, Incandescent, Electric Discharge, Fluorescent, Arc lamps, Lasers, Neon signs, Energy Efficiency, LED - LCD displays, Luminaries, Wiring, Switching, Control circuits.

**UNIT III**

**10 Hours**

**CALCULATION AND MEASUREMENT**

Luminance measurement, Effect of voltage variation, Lighting calculations and characteristic curves, Solid angle, Inverse square and cosine laws, Illumination from point, line and surface sources, Photometry and Spectro - photometry, photocells.

**UNIT IV**

**10 Hours**

**INTERIOR LIGHTING**

Lighting design procedure for Industrial, Residential, Office, Departmental stores, Indoor stadium, Theatres and Hospitals-Energy Efficient Lighting.

**UNIT V**

**10 Hours**

**EXTERIOR LIGHTING**

Environment and glare, Lighting Design procedure for Flood, Street, Sport, Aviation and Transport lighting, Lighting for Displays and Signalling-Energy Efficient Lighting.

**FURTHER READING**

Special Features of Aesthetic Lighting : Monument and statue lighting, Auditorium lighting

**Total: 45 Hours**

**Reference(s)**

1. Joseph B. Murdoch, Illumination Engineering from Edisons Lamp to the Laser, Visions Communications, Washington DC, USA, 1994
2. Jack L. Lindsey, Applied Illumination Engineering, Prentice Hall of India, New Delhi, 2008.
3. Marc Schiler, Simplified Design of Building Lighting, John Wiley and Sons, 1997.
4. IES Lighting Handbook, 1993.
5. D.C. Pritchard, Lighting, Routledge, 6th Edition, 2016

**21EE034 ELECTRICAL SAFETY****3 0 0 3****Course Objectives**

- To provide knowledge on basics of electrical fire and statutory requirements for electrical safety.
- To understand the causes of accidents due to electrical hazards.
- To know the various protection systems in Industries from electrical hazards.
- To know the importance of earthing.
- To distinguish the various hazardous zones and applicable fire proof electrical devices.

**Programme Outcomes (POs)**

- f. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- g. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- m.PSO1: Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n.PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Analyze the basic concepts in electrical circuit and hazards involved in it.
2. Analyze the electrical hazards in the workplace and its impacts.
3. Examine the operation of various protection systems from electrical hazards.
4. Analyze the various safety procedures involved in the industries.
5. Explore the different hazardous zones in Industries and their safety measures.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	-	-	-	-	-	2	1	-	-	-	-	-	2	-
2	-	-	-	-	-	1	2	-	-	-	-	-	1	2
3	-	-	-	-	-	2	-	-	-	-	-	-	2	1
4	-	-	-	-	-	2	1	-	-	-	-	-	1	-
5	-	-	-	-	-	2	1	-	-	-	-	-	2	1

**UNIT I****9 Hours****CONCEPTS AND STATUTORY REQUIREMENTS**

Review of Electrical concept - electrostatics, electro magnetism, stored energy - working principles of major electrical equipment - Indian electricity act and rules - statutory requirements from electrical inspectorate- international standards on electrical safety.

**UNIT II****9 Hours****ELECTRICAL HAZARDS**

Primary and secondary hazards - Energy leakage - clearances and insulation - current surges - electrical causes of fire and explosion - national electrical safety code ANSI- Lightning hazards.

**UNIT II**

**9 Hours**

**PROTECTION SYSTEMS**

Fuse, circuit breakers and types - protection against over voltage and under voltage - safe limits of amperage - safe distance from lines - overload and short circuit protection - earth fault protection. - system grounding - equipment grounding - earth leakage circuit breaker (ELCB) - ground fault circuit interrupter - electrical guards - Personal protective equipment.

**UNIT IV**

**9 Hours**

**SELECTION, INSTALLATION, OPERATION AND MAINTENANCE**

Role of environment in selection - protection and interlock - discharge rod and earthing devices - safety in the use of portable tools - preventive maintenance.

**UNIT V**

**9 Hours**

**HAZARDOUS AREAS**

Hazardous area classification and classification of electrical equipment for hazardous areas (IS, API and OSHA standards)- classification of equipment/enclosure for hazardous locations.

**Total: 45 Hours**

**Reference(s)**

1. Fordham Cooper, W., “Electrical Safety Engineering, Butterworth and Company”, London, Third Edition,2013.
2. “Indian Electricity Act and Rules”, Government of India.
3. “Power Engineers”, Handbook of TNEB, Chennai, 2010.
4. “Accident prevention manual for industrial operations”, N.S.C., Chicago, 1982.
5. John Cadick, P.E., Mary Capelli-Schellpfeffer, Dennis K. Neitzel, Al Winfield, “Electrical Safety Handbook”,Fourth Edition, Tata Mcgraw Hill, 2014.

**21EE035 ENERGY AUDITING AND MANAGEMENT 3 0 0 3****Course Objectives**

- To understand the Indian energy scenario and international energy policies.
- To study the energy utilization of electrical systems.
- To analyse the energy audit techniques by using suitable tools and energy balance.
- To study the energy management features and audit procedure.
- To gain the knowledge on financial management in energy audit.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
  - Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- m.PSO1: Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n.PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Analyze the importance of energy policies, energy conservation act features and energy security.
- Apply the different energy conservation technique involved in electrical and electromechanical devices.
- Apply the suitable energy audit technique using appropriate tools to improve the system efficiency with mass and energy balance concept.
- Analyze the suitable energy audit technique, procedure and bench marking in energy audit.
- Analyze the energy conservation opportunities and the various financial technique adopted in energy management.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	-	-	-	-	2	-	-	-	-	-	3	
2	2	2	-	-	-	-	-	-	-	-	-	-	2	3
3	1	2	-	-	-	-	-	-	-	-	-	-	2	1
4	2	2	-	-	-	-	-	-	-	-	-	-	3	
5	1	2	-	-	-	-	-	-	-	-	-	-	2	1

**UNIT I****10 Hours****ENERGY SCENARIO AND ENERGY POLICY**

Role of energy in economic development and social transformation- Indian energy scenario- Energy statistics 2021- international energy policies-G20 and OPEC countries - Need for use of new and non-renewable Energy-Energy conservation act-2001 & its features - Energy Security.

**UNIT II****8 Hours****ELECTRICAL ENERGY UTILITY SYSTEM**

Transmission and Distribution Losses-Transformer losses - Electricity Tariff- Load management and maximum demand control- Electric motor-losses in induction motor- efficiency calculation-factors affecting motor performance-power factor - energy efficient motors.

**UNIT III**

**7 Hours**

**ENERGY AUDIT INSTRUMENTS AND ENERGY BALANCE**

Electrical measurements- Instruments used in energy audit: Wattmeter - flue gas analysers- PQ analyzers- infrared Thermography-Energy efficiency calculation in lighting, pump Applications-Material balance- energy balance - features

**UNIT IV**

**10 Hours**

**ENERGY MANAGEMENT AND AUDIT**

Definition and objective of energy management - Principle of energy management - Key elements of energy management -Roles and responsibilities of energy manager - energy audit definition -types- Detailed energy audit procedure- understanding energy cost -Bench marking.

**UNIT V**

**10 Hours**

**EVALUATION OF SAVING OPPORTUNITIES AND FINANCIAL MANAGEMENT**

Determination of cost saving -conservation opportunities - Estimating cost of implementation -Financial analysis techniques-plant energy audit report - Simple payback period, Return on investment, Net present value, Internal rate of return.

**FOR FURTHER READING**

Energy conservation and management -case studies - BEE rules and regulations.

**Total: 45 Hours**

**Reference(s)**

1. Jose Golden Berg, Thomas Johansson, A K N Reddy, Robert Williams “Energy for a sustainable world”, WileyEastern, 1988.
2. BEE reference book 1/2/3/4
3. Albert Thumann,Terry Niehus “A Handbook of Energy Audits”, Ninth Edition, 2012.
4. Charles E Brown, “World Energy Resources”, Springer, 2012.

**21EE036 PLC and SCADA****3 0 0 3****Course Objectives**

- To understand the architecture of PLC
- To understand the PLC programming using ladder logic and instructions
- To develop a real time models using PLC for required applications.
- To understand the architecture and types of SCADA
- To interface the PLC with SCADA

**Programme Outcomes (POs)**

- a. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- f. 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.
- m.PSO1: Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n.PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Understand the network and communication devices for interfacing computer with PLC.
2. Analyse the different programming languages used in PLC.
3. Create and execute a ladder logic for the particular industrial application.
4. Understand the architecture of SCADA and its types.
5. Apply the Supervisory Control and Data Acquisition for the particular industrial application.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	-	-	-	-	-	-	-	-	-	-	2	1
2	2	3	-	-	-	-	-	-	-	-	-	-	2	2
3	2	2	-	-	-	3	-	-	-	-	-	-	2	3
4	3	3	-	-	-	-	-	-	-	-	-	-	2	2
5	2	3	-	-	-	3	-	-	-	-	-	-	2	3

## UNIT I

8 Hours

### ARCHITECTURE OF PLC

Components of PLC - sink and source I/O cards - Processor - Memory: Types of memory, Input and Output modules: Discrete, Analog -Scan time of PLC -Interfacing computer and PLC: RS232, RS485, Ethernet - Selection criteria for PLC

## UNIT II

10 Hours

### PLC PROGRAMMING

Programming languages - Ladder logic components: User, bit, branch and internal relay instruction -Boolean logic - Latching -Timers and Counters.

Instructions in PLC: Program Control, Math, Data Manipulation – Sequencer, Shift register and Analog Instructions.

## UNIT III

9 Hours

### APPLICATIONS OF PLC

Case Studies: Motor control- Bottle filling system - Pick and place robot - Car Parking - Traffic light control-Elevators - Pneumatic stamping system - alarm control system

## UNIT IV

8 Hours

### INTRODUCTION SCADA

Supervisory Control and Data Acquisition-Architecture/block diagram, Benefits of SCADA Types of SCADA- SCADA System Hardware -Remote terminal unit-Master terminal unit-Data Storage- Application area of SCADA.

## UNIT V

10 Hours

### SCADA INTERFACING AND APPLICATIONS

Connection Diagram - Object Linking and Embedding for Process controlarchitecture – Steps in creating SCADA- Steps for Linking SCADA Object with PLC using OPC- Concept of Tag, Applications of SCADA: On-off Control Lamp, Traffic Light Control– Elevator system – conveyor system

### FOR FURTHER READING

Distributed control System

**Total: 45 Hours**

### Reference(s)

1. F.D. Petruzella, “Programmable Logic Controllers”, Tata Mc-Graw Hill, Third edition, 2015
2. John W Webb and Ronald A Resis, “Programmable Logic Controller”, Prentice Hall of India Pvt. Ltd., New Delhi, 2013
3. Hackworth, John Hackworth, “Federic Programmable logic controllers”, Prentice Hall of India Pvt. Ltd., New Delhi, 2013
4. Katariya Sanjay B, “Industrial Automation Solutions for PLC, SCADA, Drive and Field Instruments”, Notion Press; 1st edition, 2020.
5. Bailey David, Wright Edwin, “Practical SCADA for Industry”, Elsevier Publication 2003.

**21EE037 ARTIFICIAL INTELLIGENCE IN ELECTRICAL ENGINEERING****3 0 0 3****Course Objectives**

- To understand the models of artificial neural networks.
- To understand the deep learning methodologies
- To understand the concept of fuzzy logic principles.
- To understand the Genetic Algorithm and Particle Swarm Optimization.
- To apply the machine learning and deep learning techniques for practical applications

**Programme Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c. 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.
- d. 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.
- m. PSO1: Design, analyze, and evaluate the performance of Electrical and Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n. PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

1. Analyze the various artificial neural network algorithms.
2. Analyze the different methodologies used in deep learning
3. Apply the concept of fuzzy logic in Electrical systems.
4. Analyze the Genetic and Particle Swarm Optimization algorithms.
5. Apply the various artificial intelligence techniques in electrical systems.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	2	-	-	-	-	-	-	-	-	2	2
2	3	2	2	2	-	-	-	-	-	-	-	-	2	2
3	3	2	2	2	-	-	-	-	-	-	-	-	2	2
4	3	2	2	2	-	-	-	-	-	-	-	-	2	2
5	3	3	3	3	-	-	-	-	-	-	-	-	2	3

**UNIT I****9 Hours****ARTIFICIAL NEURAL NETWORK**

Artificial neuron, activation function, supervised, unsupervised learning, Single layer perceptron – Limitation – Multi layer perceptron – Back Propagation Algorithm (BPA) – Recurrent Neural Network (RNN) – Adaptive Resonance Theory (ART) based network – Radial basis function network – Reinforcement learning.

**UNIT II** **9 Hours**

**DEEP NEURAL NETWORKS**

Convolutional Neural networks- LeNet- AlexNet – GoogLeNet – ResNet - Long Short-Term Memory- Gate Recurrent Unit- Deep Belief Network - Ensemble methods: Bagging, boosting, Evaluating and debugging learning algorithms

**UNIT III** **9 Hours**

**FUZZY SET THEORY**

Fuzzy Sets – Set-theoretic operations – Member Function Formulation and parameterization – Fuzzy Rules and Fuzzy Reasoning - Extension principle and Fuzzy Relations – Fuzzy If-Then Rules – Fuzzy Reasoning – Fuzzy Inference Systems – Mamdani Fuzzy Models-Sugeno Fuzzy Models – Tsukamoto Fuzzy Models – Input Space Partitioning and Fuzzy Modeling.

**UNIT IV** **9 Hours**

**GENETIC ALGORITHM AND PARTICLE SWARM OPTIMIZATION**

Genetic Algorithms-Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators – Particle Swarm Optimization- Topologies – Control parameters.

**UNIT V** **9 Hours**

**AI APPLICATIONS**

Load forecasting - Fault Identification in transmission lines - Energy management in Micro Grid - Duty ratio optimization in power converters.

**Total: 45 Hours**

**Reference(s)**

1. Ethem Alpaydin, Introduction to Machine Learning, Fourth Edition, MIT Press, 2020.
2. Andrew Glassner, Deep Learning: From Basics to Practice , First Edition, The Imaginary Institute, Seattle, 2018.
3. H J Zimmermann, Fuzzy set theory and its application, Second Edition, Allied Publishers, 2014.
4. Xin-She Yang , Nature – Inspired Optimization Algorithms, Second Edition , Elsevier , 2020.
5. Gheisarnejad, Meysam, Hamed Farsizadeh, and Mohammad Hassan Khooban. "A novel nonlinear deep reinforcement learning controller for DC–DC power buck converters." IEEE Transactions on Industrial Electronics 68.8 (2020): 6849-6858.
6. Asbery, Chris, and Yuan Liao. "Fault identification on electrical transmission lines using artificial neural networks." Electric Power Components and Systems 49.13-14 (2022): 1118-1129.
7. Aguila-Leon, Jesus, Vargas-Salgado, C., Chiñas-Palacios, C., & Díaz-Bello, D. "Energy management model for a standalone hybrid microgrid through a particle Swarm optimization and artificial neural networks approach." Energy Conversion and Management 267 (2022): 115920.

**21EE038 BIG DATA ANALYTICS FOR SMART GRID****3 0 0 3****Course Objectives**

- To understand the fundamental concepts of big data analytics.
- To understand the fundamentals of various big data analytics techniques
- To apply concept of cloud computing techniques for smart grid.
- To apply the big data analytics for smart grid data management.
- To analyse the smart metering data set in the power system.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
  - Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - 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.
  - 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.
- n. PSO2: Apply the core knowledge and technical skills to develop reliable and sustainable solutions to real world problems.

**Course Outcomes (COs)**

1. Apply the concepts of big data applications for smart grid.
2. Analyse the big data tools and its analysis techniques.
3. Analyse the benefits of cloud computing in smart grid technology.
4. Analyse the role of big data in smart grid data management system.
5. Design solutions for smart grid system using big data analytics.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	2	2	-	-	-	-	-	-	-	-	-	2
2	3	2	2	2	-	-	-	-	-	-	-	-	-	2
3	3	2	2	2	-	-	-	-	-	-	-	-	-	2
4	3	2	2	2	-	-	-	-	-	-	-	-	-	2
5	3	2	2	2	-	-	-	-	-	-	-	-	-	2

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

Introduction to Big Data Analytics - Fundamental Mathematical Prerequisites, Big Data Era, General Security Challenges - Challenges of conventional systems - Modern data analytic tools. History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System.

**UNIT II**

**9 Hours**

**DATA ANALYSIS**

Regression modeling, Multivariate analysis, Bayesian modeling, inference and Bayesian networks, Support vector and kernel methods, Analysis of time series: linear systems analysis, nonlinear dynamics - Rule induction. Sampling and large sample tests, chi- square test, theory of estimation, linear and polynomial fitting by the methods, correlation of bivariate frequency distribution.

**UNIT III**

**9 Hours**

**CLOUD COMPUTING APPLICATIONS FOR SMART GRID**

Cloud computing in smart grid, Cloud computing architecture, Demand Response - Geographical Load- Balancing - Dynamic Pricing - Virtual Power Plant - Advanced Metering Infrastructure - Cloud-Based Security and Privacy.

**UNIT IV**

**9 Hours**

**SMART GRID DATA MANAGEMENT AND APPLICATIONS**

Pricing and energy forecasting in Demand Response, case study on Energy Forecast, Smart Meter Data Management -PHEVs: Internet of Vehicles - Smart Buildings.

**UNIT V**

**9 Hours**

**SMART GRID DESIGN AND DEPLOYMENT**

Attack detection, current problem and techniques, Secure Data Learning Scheme, Logical Security Architecture, Smart Metering Data Set Analysis—A Case Study, Security Schemes for AMI Private Networks, Simulation Tools- Worldwide Initiatives - Use of data analytics for renewable energy integration and grid resilience

**FOR FURTHER READING**

Legal Protection of Personal Data in Smart Grid and Smart Metering Systems, Phases of smart grid system development cycle, Smart Grid Security and Privacy of Customer-Side Networks

**Total: 45 Hours**

**Reference(s)**

1. Smart Grid Technology: A Cloud Computing and Data Management Approach, S. Misra and S. Bera, Cambridge University Press, 2018, 1st Edition.
2. Smart Grid Communication Infrastructure: Big Data, Cloud Computing and Security, F. Ye, Y. Qian and R.Q. Hu, Wiley IEEE Press, 2018, 1st Edition.
3. Smart Grid: Fundamentals of Design and Analysis, James A. Momoh, Wiley India, 2015, 1st Edition.
4. Big Data and Analytics, Seema Acharya, Subhashini Chellapan,, Wiley, 2015.
5. Big data analytics in future power systems, Ahmed F. Zobaa, Trevor J. Bihl, 1st Edition, CRC press 2018.

**21EE039 INDUSTRY 4.0****3 0 0 3****Course Objectives**

- To expose the various stages of industrial revolutions.
- To introduce and familiarize the industry 4.0 and its physical structure and interconnectivity.
- To understand the different Automation Systems concepts for various sectors from the Industry 4.0 perspective.
- To outline the cloud computing and cyber security in the robotics industry.
- To understand the concepts VR systems, work and list the applications of VR.

**Programme Outcomes (POs)**

- Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
  - Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
  - 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.
  - 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.
  - Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- m.PSO1: Design, analyze, and evaluate the performance of Electrical & Electronics systems using contemporary tools to provide effective solutions for real-world problems.
- n.PSO2: Apply technology to make a significant contribution in terms of Electrical Engineering Innovations and ethically supporting the sustainable development of the society.

**Course Outcomes (COs)**

- Apply the concept of Industry 4.0 transformation in industries.
- Analyse the various systems used in a manufacturing plant and their role in an Industry 4.0 world.
- Apply the concept Understand the smartness in Smart Factories, Smart cities, smart products and smart Services.
- Analyze the types of Cloud computing and cyber security in a networked industrial System.
- Analyze the Virtual reality requirements in the industries .

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	2	3	-	-	-	-	-	-	-	-	3	3
2	2	2	2	3	-	-	-	-	-	-	-	-	3	3
3	2	2	2	3	2	-	-	-	-	-	-	-	2	2
4	2	2	2	3	3	-	-	-	2	-	-	-	2	2
5	2	2	2	3	3	-	-	-	2	-	-	-	2	2

**UNIT I** **9 Hours**

**INTRODUCTION**

Introduction, core idea of Industry 4.0, origin concept of industry 4.0, Industry 4.0 production system, current state of industry 4.0, Technologies, how is India preparing for Industry 4.0.

**UNIT II** **9 Hours**

**CONCEPTUAL FRAMEWORK**

Main Concepts and Components of Industry 4.0, State of Art, supportive Technologies: Proposed framework for Industry 4.0, Obstacles and Framework Conditions for Industry 4.0.

**UNIT III** **9 Hours**

**TECHNOLOGY ROADMAP**

Proposed Framework for Technology Roadmap, Strategy Phase, New Product and Process Development Phase ,Case Study: Smart Manufacturing, Smart Devices and Products.

**UNIT IV** **9 Hours**

**ADVANCES IN ROBOTICS**

Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly.

**UNIT V** **9 Hours**

**VIRTUAL REALITY**

Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, VR Hardware and Software Technology, Industrial Applications of VR.

**Total: 45 Hours**

**Reference(s)**

1. Alp Ustundag, Emre Cevikcan, "Industry 4.0: Managing the Digital Transformation", springer, 2017.
2. Lane Thames, Dirk Schaefer, "Cybersecurity for Industry 4.0: Analysis for Design and Manufacturing", springer, 2017.
3. Diego Galar Pascual, Pasquale Daponte, Uday Kumar, "Handbook of Industry 4.0 and SMART Systems", Taylor and Francis,2020.
4. Steven M. LaValle, "Virtual Reality", Cambridge University Press, 2016.
5. William R Sherman and Jeffrey D Will, Morgan Kaufmann, Alan B Craig, "Developing Virtual Reality Applications: Foundations of Effective Design", 2009.