SRI VENKATESWARA COLLEGE OF ENGINEERING,

(An Autonomous Institution, Affiliated to Anna University, Chennai – 600025)

B.E., Electrical and Electronics Engineering

CURRICULUM AND SYLLABUS

REGULATION – 2022

CHOICE BASED CREDIT SYSTEM

Curriculum Revision No:		Board of Studies recommendation date:	07.10.2022 10.04.2023 19.09.2023 03.04.2024	Academic Council Approved date:	08.10.2022 21.04.2023 23.09.2023 09.05.2024
Salient Points of the revision	01.	The Program Specific Outcomes is revised which focuses on Automation with smart Design and Development.			
	02.	Two Tamil language courses are introduced in semesters I and II with a total of 3 credits.			
	03.	New theory course “Measurement and Instrumentation” has been introduced.			
	04.	Four new hybrid Theory - Laboratory courses are introduced.			
	05.	Mini project has been introduced.			
	06.	Special Elective courses are grouped under vertical I. Professional Elective courses are grouped under six verticals (II to VII) of different domains.			
	07.	One Laboratory course is introduced in each of the six verticals of the Professional elective courses.			
	08.	Industry supported course included.			
	09.	Specialization in same discipline (Honors degree) and Specialization in other discipline (Minor degree) has been introduced.			
	10.	Two Value added courses (4 credits) is made as mandatory.			
	11.	Industrial Training/Internship for 2 credits is made as mandatory.			

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REGULATIONS 2022

B. E ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

I. Graduates will serve as engineering contributors in the emerging fields of Electrical and Electronics Engineering.

II. Graduates will become entrepreneurs through human centered design thinking and innovation.

III. Graduates will be successful in pursuing higher studies in engineering or management.

IV. Graduates will be effective and ethical team player in the field of green energy management and sustainability.

PROGRAM OUTCOMES (POs)

GRADUATE ATTRIBUTES:

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

2. **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.

3. **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.

4. **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.

5. **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.

6. **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.

7. **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.

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

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

10. **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.

11. **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.

12. **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.

PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Design, analyse and implement Power Electronics circuit with smart control systems for Industrial drives and Electric Vehicles.

2. Analyse safety, stability, control and protection of vertical and deregulated Smart systems and interconnection of microgrid comprising Renewable, Storage and Nano technologies.

PEO's – PO's & PSO's MAPPING:

POs	**PEOs**			
	I	**II**	**III**	**IV**
1	✓	✓	✓	
2	✓	✓	✓	
3	✓		✓	
4	✓		✓	
5	✓	✓	✓	
6		✓		✓
7		✓		✓
8		✓		✓
9		✓	✓	✓
10		✓	✓	✓
11		✓	✓	✓
12	✓	✓	✓	
PSOs				
1	✓		✓	✓
2	✓		✓	✓

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REGULATIONS 2022

CHOICE BASED CREDIT SYSTEM

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CURRICULUM FOR SEMESTERS I TO VIII

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY#	PERIODSPER WEEK				TOTAL HOURS	PREREQ-UISITE	POSITION
				L	T	P	C			
1.	IP22151	Induction Program (Common to all branches)		-	-	-	-	-	NIL	F
Theory Subjects										
2.	HS22151	Tamil language and Heritage of Ancient Tamil Society (Common to all branches)	HS	1	0	0	1	1	NIL	F
3.	HS22152	Communicative English (Common to all branches)	HS	3	0	0	3	3	NIL	F
4.	MA22151	Applied Mathematics I (Common to all branches except MR)	BS	3	1	0	4	4	NIL	F
5.	PH22151	Applied Physics (Common to AD, CS, EE, EC, IT)	BS	3	0	0	3	3	NIL	F
6.	CY22151	Applied Chemistry (Common to AD, CS, EE, EC, IT)	BS	3	0	0	3	3	NIL	F
7.	CM22151	Basic Civil and Mechanical Engineering	ES	3	0	0	3	3	NIL	F
8.	IT22101	Programming for Problem Solving (Common to IT, AD, CS, EE, EC)	ES	3	0	0	3	3	NIL	F
Practical Subjects										
9.	EE22111	Basic Electrical and Electronics Engineering Laboratory (Common to all branches except EC)	ES	0	0	2	1	2	NIL	F
10.	ME22161	Basic Civil and Mechanical Engineering Laboratory (Common to CE, EE, EC)	ES	0	0	2	1	2	NIL	F
11.	IT22111	Programming for Problem Solving Laboratory (Common to IT, AD, CS, EE, EC)	ES	0	0	3	1.5	3	NIL	F
			Total	**19**	**1**	**7**	**23.5**	**27**		

SEMESTER II

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODSPER WEEK				TOTAL HOURS	PREREQ-UISITE	POSITION
				L	T	P	C			
Theory Subjects										
1.	HS22251	Science and Technology in Ancient Tamil Society (Common to all branches)	HS	2	0	0	2	2	NIL	F
2.	HS22252	Technical English (Common to all branches)	HS	3	0	0	3	3	NIL	F
3.	MA22251	Applied Mathematics II (Common to all branches except MR)	BS	3	1	0	4	4	NIL	F
4.	PH22252	Physics of Materials (Common to EE and EC)	BS	3	0	0	3	3	NIL	F
5.	ME22252	Fundamentals of Engineering Graphics	ES	2	0	2	3	4	NIL	F
6.	EE22201	Electric Circuit Analysis	PC	3	1	0	4	4	NIL	F
Practical Subjects										
7.	PH22161	Physics Laboratory (Common to all branches except BT)	BS	0	0	2	1	2	NIL	F
8.	CY22161	Chemistry Laboratory (Common to all branches except AD, CS, IT)	BS	0	0	2	1	2	NIL	F
9.	EE22211	Electric Circuits Laboratory	PC	0	0	3	1.5	3	NIL	F
			Total	**16**	**2**	**9**	**22.5**	**26**		

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY#	PERIODSPER WEEK				TOTAL HOURS	PREREQ-UISITE	POSITION
				L	T	P	C			
Theory Subjects										
1.	MA22354	Mathematics For Electrical Engineers	BS	3	1	0	4	4	NIL	F
2.	EE22301	Electrical Machines I	PC	3	0	0	3	3	NIL	F
3.	EE22302	Electric Power System	PC	3	0	0	3	3	NIL	F
4.	EE22303	Electromagnetic Theory	PC	3	0	0	3	3	NIL	F
5.	EE22308	Digital Logic Circuits: Theory and Practices	PC	3	0	2	4	5	NIL	F
6.	EE22309	Electron Devices and Circuits: Theory and Practices	PC	3	0	2	4	5	NIL	F
Practical Subjects										
7.	EE22311	Electrical Machines I Laboratory	PC	0	0	3	1.5	3	NIL	F
			Total	**18**	**1**	**7**	**22.5**	**26**		

SEMESTER IV

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODSPER WEEK				TOTAL HOURS	PREREQ-UISITE	POSITION
				L	T	P	C			
Theory Subjects										
1.	MA22452	Numerical Methods (Common to CH and EE)	BS	3	1	0	4	4	NIL	F
2.	GE22451	Environmental Sciences and Sustainability (Common to all branches)	BS	3	0	0	3	3	NIL	F
3.	EE22401	Analog Electronics	PC	3	0	0	3	3	NIL	F
4.	EE22402	Control Systems	PC	3	0	0	3	3	NIL	F
5.	EE22403	Electrical Machines II	PC	3	0	0	3	3	NIL	F
6.	EE22404	Measurement and Instrumentation	PC	3	0	0	3	3	NIL	F
Practical Subjects										
7.	EE22411	Analog Electronics Laboratory	PC	0	0	3	1.5	3	NIL	F
8.	EE22412	Control Systems and Instrumentation Laboratory	PC	0	0	3	1.5	3	NIL	F
9.	EE22413	Electrical Machines II Laboratory	PC	0	0	3	1.5	3	NIL	F
			Total	**18**	**1**	**9**	**23.5**	**28**		

SEMESTER V

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODSPER WEEK				TOTAL HOURS	PREREQ-UISITE	POSITION
				L	T	P	C			
Theory Subjects										
1.	EE22501	Microcontrollers and Programming	PC	3	0	0	3	3	NIL	F
2.	EE22502	Power Electronics	PC	3	0	0	3	3	NIL	F
3.	EE22503	Power System Analysis	PC	3	0	0	3	3	NIL	F
4.	IT22551	Programming and Data Structures	PC	3	0	0	3	3	NIL	F
5.		Professional Elective I	PE	3	0	0	3	3	NIL	M
6.		Open Elective I	OE	3	0	0	3	3	NIL	M
Practical Subjects										
7.	EE22511	Microcontrollers and Programming Laboratory	PC	0	0	3	1.5	3	NIL	F
8.	EE22512	Power Electronics Laboratory	PC	0	0	3	1.5	3	NIL	F
9.	IT22561	Programming and Data Structures Laboratory	PC	0	0	3	1.5	3	NIL	F
			Total	**18**	**0**	**9**	**22.5**	**27**		

SEMESTER VI

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODSPER WEEK				TOTAL HOURS	PREREQ-UISITE	POSITION
				L	T	P	C			
Theory Subjects										
1.	EE22601	Digital Signal Processing	PC	3	0	0	3	3	NIL	F
2.	EE22602	Industrial Automation and Networking (Industry supported)	PC	3	0	0	3	3	NIL	F
3.	EE22603	Power System Operation and Control	PC	3	0	0	3	3	NIL	F
4.		Professional Elective II	PE	3	0	0	3	3	NIL	M
5.		Open Elective II	OE	3	0	0	3	3	NIL	M
6.		Mandatory Courses	MC	3	0	0	0	3	NIL	M
Practical Subjects										
6.	HS22511	Interview and Career Skills Laboratory (Common to all branches except CE)	HS	0	0	3	2	3	NIL	F
7.	EE22611	Industrial Automation Laboratory	PC	0	0	4	2	4	NIL	F
8.	EE22612	Power System Laboratory	PC	0	0	3	1.5	3	NIL	F
			Total	**15**	**0**	**10**	**20.5**	**28**		

SEMESTER VII

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODSPER WEEK				TOTAL HOURS	PREREQ-UISITE	POSITION
				L	T	P	C			
Theory Subjects										
1.	EE22701	Protection and Switchgear	PC	3	0	0	3	3	NIL	F
2.	EE22708	Smart Grid: Theory and Practices	PC	3	0	2	4	5	NIL	F
3.	EE22709	Electric Vehicles: Theory and Practices	PC	3	0	2	4	5	NIL	F
4.		Professional Elective III	PE	3	0	0	3	3	NIL	M
5.		Professional Elective IV	PE	3	0	0	3	3	NIL	M
Practical Subjects										
6.	EE22711	Mini Project	EEC	0	0	4	2	4	NIL	F
7.	EE22712	Industrial Training/Internship	EEC	0	0	0	2	4 weeks	NIL	M
Total				**15**	**0**	**4**	**21**	**25**		

SEMESTER VIII

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODSPER WEEK				TOTAL HOURS	PREREQ-UISITE	POSITION
				L	T	P	C			
Theory Subjects										
1.		Professional Elective V	PE	3	0	0	3	3	NIL	M
2.		Professional Elective VI	PE	3	0	0	3	3	NIL	M
Practical Subjects										
3.	EE22811	Project work	EEC	0	0	16	8	16	NIL	F
			Total	**6**	**0**	**16**	**14**	**22**		

Total Credits:170

VERTICALS I: SPECIAL ELECTIVE GROUP

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODS PER WEEK				TOTAL HOURS	POSITION
				L	T	P	C		
1.	SE22001	Financial Statement Analysis (Common to All Branches)	EEC	3	0	0	3	3	M
2.	SE22002	Introduction to Securities Market (Common to All Branches)	EEC	3	0	0	3	3	M
3.	SE22003	Option Trading Strategies (Common to All Branches)	EEC	3	0	0	3	3	M
4.	SE22004	Corporate Finance (Common to All Branches)	EEC	3	0	0	3	3	M
5.	SE22005	Managerial Economics (Common to All Branches)	EEC	3	0	0	3	3	M
6.	SE22006	Project Management (Common to All Branches)	EEC	3	0	0	3	3	M
7.	SE22007	Mathematics for AI and ML (Common to All Branches)	EEC	3	0	0	3	3	M

PROFESSIONAL ELECTIVE COURSES: VERTICALS					
VERTICAL II Power System Engineering	**VERTICAL III Electrical Drives and Control**	**VERTICAL IV Electric Vehicle Technology**	**VERTICAL V Renewable Energy and Engineering**	**VERTICAL VI Semiconductor Technology**	**VERTICAL VII Diversified Group-I**
Restructured Power Systems	Modeling and Analysis of Electrical Machines	Hybrid Electric Vehicles	Distributed Generation and Microgrid	Solid State Devices	Analog and Digital Controllers
Substation Automation	Special Electrical Machines and Drives	Vehicle Dynamics	Solar Energy Conversion System	Microelectronic circuits	Biomedical Instrumentation
HVDC and FACTS	Computer Aided Design of Electrical Apparatus	Automotive Power Electronics	Wind Energy Conversion System	Semiconductor Technology	Ethics in Electrical Engineering
Power System Dynamics	SMPS and UPS	Energy Storage System and Management in EV	Hybrid Renewable System and Storage Technologies	Physical VLSI Design (Common to EC and EE)	IoT in Automation and Control
High Voltage Engineering	Analysis of Power Converters	Electric Vehicle Control	Power Quality	MEMS Technology	Computer Organization and Architecture (Common to IT and EE)
Soft Computing Techniques for Power Systems	Programming for Embedded System	Automotive Embedded Systems	Electrical Safety	Wide Bandgap Semiconductors	Artificial and Computational Intelligence
Power System Management	Microcontroller based System Design	Vehicle Communication	Energy Management and Auditing	Sensor Technology	Principles of Management (Common to ME, AE, AM, EE, IT and MN)
Digital Protection of Power System	Control System design for Power Electronics	Sustainable EV Charging Infrastructure	Electrical Energy Conservation and Utilization	Embedded System Design	Robotics and Automation (Common to EC and EE)
Power System Protection Laboratory	Electric Drives Laboratory	Electric Vehicle Laboratory	Renewable Energy System Laboratory	IC Design Laboratory	Design Thinking Laboratory

VERTICALII: POWER SYSTEM ENGINEERING

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODS PER WEEK				TOTAL HOURS	PREREQ-UISITE	POSITION
				L	T	P	C			
Theory Subjects										
1.	EE22021	Restructured Power Systems	PE	3	0	0	3	3	NIL	M
2.	EE22022	Substation Automation	PE	3	0	0	3	3	NIL	M
3.	EE22023	HVDC and FACTS	PE	3	0	0	3	3	NIL	M
4.	EE22024	Power System Dynamics	PE	3	0	0	3	3	NIL	M
5.	EE22025	High Voltage Engineering	PE	3	0	0	3	3	NIL	M
6.	EE22026	Soft Computing Techniques for Power Systems	PE	3	0	0	3	3	NIL	M
7.	EE22027	Power System Management	PE	3	0	0	3	3	NIL	M
8.	EE22028	Digital Protection of Power System	PE	3	0	0	3	3	NIL	M
Practical Subjects										
9.	EE22020	Power System Protection Laboratory	PE	0	0	4	2	4	NIL	M

VERTICAL III: ELECTRICAL DRIVES AND CONTROL

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODS PER WEEK				TOTAL HOURS	PREREQ-UISITE	POSITION
				L	T	P	C			
Theory Subjects										
1.	EE22031	Modeling and Analysis of Electrical Machines	PE	3	0	0	3	3	NIL	M
2.	EE22032	Special Electrical Machines and Drives	PE	3	0	0	3	3	NIL	M
3.	EE22033	Computer Aided Design of Electrical Apparatus	PE	3	0	0	3	3	NIL	M
4.	EE22034	SMPS and UPS	PE	3	0	0	3	3	NIL	M
5.	EE22035	Analysis of Power Converters	PE	3	0	0	3	3	NIL	M
6.	EE22036	Programming for Embedded System	PE	3	0	0	3	3	NIL	M
7.	EE22037	Microcontroller based System Design	PE	3	0	0	3	3	NIL	M
8.	EE22038	Control System design for Power Electronics	PE	3	0	0	3	3	NIL	M
Practical Subjects										
9.	EE22030	Electric Drives Laboratory	PE	0	0	4	2	4	NIL	M

VERTICAL IV: ELECTRIC VEHICLE TECHNOLOGY

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODS PER WEEK				TOTAL HOURS	PREREQ-UISITE	POSITION
				L	T	P	C			
Theory Subjects										
1.	EE22041	Hybrid Electric Vehicles	PE	3	0	0	3	3	NIL	M
2.	EE22042	Vehicle Dynamics	PE	3	0	0	3	3	NIL	M
3.	EE22043	Automotive Power Electronics	PE	3	0	0	3	3	NIL	M
4.	EE22044	Energy Storage System and Management in EV	PE	3	0	0	3	3	NIL	M
5.	EE22045	Electric Vehicle Control	PE	3	0	0	3	3	NIL	M
6.	EE22046	Automotive Embedded Systems	PE	3	0	0	3	3	NIL	M
7.	EE22047	Vehicle Communication	PE	3	0	0	3	3	NIL	M
8.	EE22048	Sustainable EV Charging Infrastructure	PE	3	0	0	3	3	NIL	M
Practical Subjects										
9.	EE22040	Electric Vehicle Laboratory	PE	0	0	4	2	4	NIL	M

VERTICALV: RENEWABLE ENERGY AND ENGINEERING

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODS PER WEEK				TOTAL HOURS	PREREQ-UISITE	POSITION
				L	T	P	C			
Theory Subjects										
1.	EE22051	Distributed Generation and Microgrid	PE	3	0	0	3	3	NIL	M
2.	EE22052	Solar Energy Conversion System	PE	3	0	0	3	3	NIL	M
3.	EE22053	Wind Energy Conversion System	PE	3	0	0	3	3	NIL	M
4.	EE22054	Hybrid Renewable System and Storage Technologies	PE	3	0	0	3	3	NIL	M
5.	EE22055	Power Quality	PE	3	0	0	3	3	NIL	M
6.	EE22056	Electrical Safety	PE	3	0	0	3	3	NIL	M
7.	EE22057	Energy Management and Auditing	PE	3	0	0	3	3	NIL	M
8.	EE22058	Electrical Energy Conservation and Utilization	PE	3	0	0	3	3	NIL	M
Practical Subjects										
9.	EE22050	Renewable Energy System Laboratory	PE	0	0	4	2	4	NIL	M

VERTICAL VI: SEMICONDUCTOR TECHNOLOGY

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODS PER WEEK				TOTAL HOURS	PREREQ-UISITE	POSITION
				L	T	P	C			
Theory Subjects										
1.	EE22061	Solid State Devices	PE	3	0	0	3	3	NIL	M
2.	EE22062	Microelectronic Circuits	PE	3	0	0	3	3	NIL	M
3.	EE22063	Semiconductor Technology	PE	3	0	0	3	3	NIL	M
4.	EC22504	Physical VLSI Design (Common to EC and EE)	PE	3	0	0	3	3	NIL	M
5.	EE22064	MEMS Technology	PE	3	0	0	3	3	NIL	M
6.	EE22065	Wide Bandgap Semiconductors	PE	3	0	0	3	3	NIL	M
7.	EE22066	Sensor Technology	PE	3	0	0	3	3	NIL	M
8.	EE22067	Embedded System Design	PE	3	0	0	3	3	NIL	M
Practical Subjects										
9.	EE22060	IC Design Laboratory	PE	0	0	4	2	4	NIL	M

VERTICALVII: DIVERSIFIED GROUP-I

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODS PER WEEK				TOTAL HOURS	PREREQ-UISITE	POSITION
				L	T	P	C			
Theory Subjects										
1.	EE22071	Analog and Digital Controllers	PE	3	0	0	3	3	NIL	M
2.	EE22072	Biomedical Instrumentation	PE	3	0	0	3	3	NIL	M
3.	EE22073	Ethics in Electrical Engineering	PE	3	0	0	3	3	NIL	M
4.	EE22074	IoT in Automation and Control	PE	3	0	0	3	3	NIL	M
5.	IT22201	Computer Organization and Architecture (Common to IT and EE)	PE	3	0	0	3	3	NIL	M
6.	EE22075	Artificial and Computational Intelligence	PE	3	0	0	3	3	NIL	M
7.	ME22087	Principles of Management (Common toME, AE, AM, EE, IT and MN)	PE	3	0	0	3	3	NIL	M
8.	EC22066	Robotics and Automation (Common to EC and EE)	PE	3	0	0	3	3	NIL	M
Practical Subjects										
9.	EE22070	Design Thinking Laboratory	PE	0	0	4	2	4	NIL	M

MANDATORY COURSES

(Course should be completed between 3rd and 6th semester)

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODSPER WEEK				TOTAL HOURS	POSITION
				L	T	P	C		
1.	MC22001	Indian Constitution (Common to all branches)	MC	3	0	0	0	45	M
2.	MC22002	Essence of Indian Traditional Knowledge (Common to all branches)	MC	3	0	0	0	45	M
3.	MC22003	Gender Sensitization (Common to all branches)	MC	3	0	0	0	45	M

GENERAL ELECTIVE COURSES

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODS PER WEEK				TOTAL HOURS	POSITION
				L	T	P	C		
1.	GN22001	Introduction to NCC for Engineers (Common to all branches)	GE	2	0	2	3	60	M
2.	GN22002	Yoga and physical culture (Common to all branches)	GE	0	0	2	1	30	M
3.	GN22003	Introduction to Fine arts (Common to all branches)	GE	2	0	0	2	30	M

VALUE ADDED COURSES (for EEE Branch)

(Course should be completed between 3rd and 6th semester and Students must earn at least 4 credits (Two value added courses))

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODS PER WEEK				TOTAL HOURS	POSITION
				L	T	P	C		
1.	VD22601	Industrial applications of Microcontrollers	VAD	1	0	2	2	45	M
2.	VD22602	Nano-device Manufacturing	VAD	1	0	2	2	45	M
3.	VD22603	Modeling and simulation of Electrical Systems	VAD	1	0	2	2	45	M
4.	VD22604	Electric Vehicle Design	VAD	1	0	2	2	45	M
5.	VD22605	Electronic circuits design and PCB Fabrication	VAD	1	0	2	2	45	M
6.	VD22606	Design and Fabrication of Photovoltaic Systems	VAD	1	0	2	2	45	M
7.	VD22607	Smart grid Cybersecurity	VAD	1	0	2	2	45	M
8.	VD22608	Applied Industrial IoT	VAD	1	0	2	2	45	M
9.	VD22609	Smart Switchgear and Protection	VAD	1	0	2	2	45	M
10.	VD22610	Content Writing	VAD	1	0	2	2	45	M

11.	VD22611	Intellectual Property Rights	VAD	2	0	0	2	30	M
12.	VD22612	Block chain technology	VAD	1	0	2	2	45	M
13.	VD22613	Digital twin and Deep learning	VAD	1	0	2	2	45	M

VALUE ADDED COURSES (Common for all Branches)

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODS PER WEEK				TOTAL HOURS	POSITION
				L	T	P	C		
1.	VC22001	Basics of Entrepreneurship Development (Common to all branches)	VAC	2	0	0	2	30	M
2.	VC22002	Advances in Entrepreneurship Development (Common to all branches)	VAC	2	0	0	2	30	M
3.	VC22003	Communicative German (Common to all branches)	VAC	2	0	0	2	30	M
4.	VC22004	Communicative Hindi (Common to all branches)	VAC	2	0	0	2	30	M
5.	VC22005	Communicative Japanese (Common to all branches)	VAC	2	0	0	2	30	M
6.	VC22006	Design Thinking and Prototyping laboratory (Common to all branches)	VAC	1	0	2	2	30	M

OPEN ELECTIVES

OPEN ELECTIVES OFFERED IN ODD SEMESTER*

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODSPER WEEK				TOTAL HOURS	POSITION
				L	T	P	C		
1.	OE22601	Biomedical Engineering	OE	3	0	0	3	3	M
2.	OE22603	Control system Engineering	OE	3	0	0	3	3	M
3.	OE22605	Micro and Smart Grid	OE	3	0	0	3	3	M
4.	OE22607	Electric Vehicle Technology	OE	3	0	0	3	3	M
5.	OE22609	Energy Conservation Practices	OE	3	0	0	3	3	M
6.	OE22611	Industrial Electrical Systems	OE	3	0	0	3	3	M
7.	OE22613	Autonomous Vehicle	OE	3	0	0	3	3	M

OPEN ELECTIVES OFFERED IN EVEN SEMESTER*

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY#	PERIODSPER WEEK				TOTAL HOURS	POSITION
				L	T	P	C		
1.	OE22602	Industrial Automation	OE	3	0	0	3	3	M
2.	OE22604	Digital Systems	OE	3	0	0	3	3	M
3.	OE22606	Motors for Industries	OE	3	0	0	3	3	M
4.	OE22608	Indian Power Grid	OE	3	0	0	3	3	M
5.	OE22610	Industrial IoT	OE	3	0	0	3	3	M
6.	OE22612	Electrical Automation and Robotics	OE	3	0	0	3	3	M
7.	OE22614	Industrial Nanotechnology	OE	3	0	0	3	3	M

ELECTRICAL AND ELECTRONICS ENGINEERING										
Subject Area	**Credits per Semester**								**Total Credits**	**Credits in %**
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
Humanities and Social Sciences (HS), including Management	4	5				2			11	**6.47**
Basic Sciences (BS) including Mathematics, Physics, Chemistry, Biology	10	9	4	7					30	**17.64**
Professional Subjects-Core (PC), relevant to the chosen specialization/branch; (May be split into Hard (no choice) and Soft (with choice), if required)		5.5	18.5	16.5	16.5	12.5	11		80.5	**47.35**
Engineering Sciences (ES), including Materials, Workshop, Drawing, Basics of, Electrical / Electronics/ Mechanical / Computer Engineering, Instrumentation	9.5	3							12.5	**7.35**
Professional Subjects – Electives (PE), relevant to the chosen specialization/ branch					3	3	6	6	18	**10.58**
Open Subjects - Electives (OE), from other technical and/or emerging subject area					3	3			6	**3.52**
Project Work, Seminar and/or Internship in Industry or Elsewhere (EEC)							4	8	12	**7.05**
Total Credits	**23.5**	**22.5**	**22.5**	**23.5**	**22.5**	**20.5**	**21**	**14**	**170**	100

SYLLABUS FOR SEMESTERS I TO VIII
SEMESTER I

HS22151	தமிழ்மொழியும்தமிழர்மரபும் Tamil language and Heritage of Ancient Tamil Society	L T P C
	(Common to all branches)	**1 0 0 1**

பாடத்தின்நோக்கங்கள்:

1. தமிழ்மொழியின்தோற்றம்பற்றியும்,
திணைகருத்துக்கள்வாயிலாகவாழ்வியல்முறைகளைபற்றியும்கற்றுக்கொள்வார்கள்.
2. இந்தியதேசியசுதந்திரஇயக்கத்தில்தமிழர்களின்பங்களிப்புமற்றும்தமிழர்களின்மேலாண்மைமுறைகளைப பற்றியும்கற்றுக்கொள்வார்கள்.

Course Objectives:

- They will learn about the origin of the Tamil language and the ways of life through five types of lands.
- They will also learn about the contribution of Tamils in the Indian National Freedom Movement and the management methods of Tamils.

அலகு 1	தமிழுக்கும்தொழில்நுட்பக்கல்விக்கும்உள்ளதொடர்பு	3

மொழிமற்றும்பாரம்பரியம்: இந்தியாவில்உள்ளமொழிக்குடும்பங்கள் – திராவிடமொழிகள் – தமிழ்ஒருசெம்மொழி – தமிழில்செம்மொழிஇலக்கியம் - உ.வே.. சாமிநாதய்யர். ஆறுமுகநாவலர் ஆகியோரின் பங்களிப்பு – தொழில்நுட்பக்கல்வியில்தமிழ்மொழியின்முக்கியத்துவம்.

UNIT -1 LANGUAGE AND HERITAGE

Language families in India – Dravidan Languages – Tamil as a Classical language – Classical Literature in Tamil – Contribution of U.Ve.Saminathaiyar. ArumukaNavalar – Importance of Tamil language in technical education.

அலகு2	திணைகருத்துக்கள்	9

திணைகருத்துக்கள்: -ஐந்துவகைநிலங்கள், விலங்குகள், கடவுள்கள், தொழில், வாழ்க்கைமுறைகள், இசை, நடனம், உணவுமுறை, தமிழர்களின்தாவரங்கள்மற்றும்விலங்கினங்கள் – தொல்காப்பியம்மற்றும்சங்கஇலக்கியங்களில்இருந்துஅகம்மற்றும்புரம்கருத்து – தமிழ்பற்றியஅறம்கருத்து – கல்விமற்றும்எழுத்தறிவுசங்ககாலம் – சங்ககாலத்தின்பண்டையநகரங்கள்மற்றும்துறைமுகங்கள் – சங்ககாலத்தில்ஏற்றுமதிமற்றும்இறக்குமதி – சோழர்களின்வெளிநாட்டுவெற்றி.

UNIT -2 THINAI CONCEPTS

Five types of lands, animals, Gods, occupation, life styles, music, dance, food style, Floara and Fauna of Tamils - Agam and puram concept from Tholkappiyam and Sangam Literature – Aram concept of Tamil – Education and Literacy during Sangam Age – Ancient cities and Ports of Sangam Age – Export and Import during Sangam Age - Overseas Conquest of Choloas.

அலகு3	தமிழரின்மரபு	3

இந்தியதேசியசுதந்திரஇயக்கம்மற்றும்இந்தியகலாச்சாரத்திற்குதமிழர்களின்பங்களிப்பு:- சுப்ரமணியபாரதி, வாஞ்சிநாதன், சுப்பிரமணியசிவா, வீரபாண்டியகட்டபொம்மன், வா..ஊசிதம்பரம்பிள்ளை, தீரன்சின்னமலை, மருதுபாண்டியசகோதரர்கள், பூலிதேவர், திருப்பூர்குமரன், வீரமங்கைவேலுநாச்சியார் - ,தமிழர்இலக்கியங்களில்மேலாண்மைகருத்துக்கள் (கி. மு. 500 முதல்கி. பி 200 வரை) – அகநானூறு, புறநானூறு,

திருக்குறள்ஆகியவற்றில்மேலாண்மைக்கருத்துகள்.

UNIT -3 HERITAGE OF TAMILS

Contribution of Tamils to Indian National Freedom Movement and Indian Culture: Contributions of Subramanya Bharathi, Vanchinathan, Subramaniya Siva, VeerapandiyaKattabomman, V O Chidambaram Pillai, Dheeran Chinnamalai, The Maruthu Pandiyar, Puli Thevar, Tiruppur Kumaran, Veera Mangai Velunachiyar.

பாடநெறிமுடிவுகள் : படிப்பைவெற்றிகரமாகமுடித்தவுடன் , மாணவர்கள்பின்வருவனவற்றைச்செய்யமுடியும்.

COURSE OUTCOMES: On the successful completion of the course, the student will be able to

பா .வெ . எண் **CO No**	பாடத்திட்டத்தின்வெளிப்பாடு **Course Outcomes**	**RBT level**
1	மாணவர்கள்தமிழ்மொழித்தோற்றம்பற்றித்தெரிந்துகொள்வார்கள். Students will learn about the origin of the Tamil language.	1
2	தமிழர்களின்வாழ்வியல்முறைகளைத்தெரிந்துகொள்வார்கள். They will know the ways of life of Tamils.	2
3	தமிழர்களின்சுதந்திரபோராட்டவீரர்களைபற்றியும், மேலாண்மைகளைபற்றியும்தெரிந்துகொள்வார்கள். They will know about the freedom fighters of Tamils and the management of Tamils.	2

பாடநூல்கள்:

1.பொன். முத்துகுமாரன்(2002), “தமிழ்மரபு”, காந்தளகம், 68, அண்ணாசாலை, சென்னை 600 002

2.பி. டிஶ்ரீனிவாசஜயங்கார்(தமிழக்கமும்திறனாய்வும்) புலவர்கா. கோவிந்தன் (1988), “தமிழர்வரலாறு (முதல்பகுதி)”, திருநெல்வேலிதென்னிந்தியசைவசித்தாந்தநூற்பதிப்புகழகம் ,154, TTK சாலை, சென்னை 18.

3.டாக்டர். கே. கே. பிள்ளை(2009), “தமிழகவரலாறுமக்களும்பண்பாடும்”, உலகதமிழாராய்ச்சிநிறுவனம், தரமணி , சென்னை 600113

4.முனைவர். ச. இராஜேந்திரன்(2004), “தமிழில்சொல்லாக்கம்”, தஞ்சாவூர்தமிழ்பல்கலைக்கழகம்வெளியீடு

HS22152	COMMUNICATIVE ENGLISH	LT P C
	(COMMON TO ALL BRANCHES)	3 0 03

COURSE OBJECTIVES

- Enable learners to interact fluently on everyday social contexts.
- Train learners to engage in conversations in an academic/scholarly setting.
- Instil confidence in learners to overcome public speaking barriers.
- Develop learners' ability to take notes and in the process, improve their listening skills.
- Enhance learners' reading skill through reading text passages for comprehension and contemplation.
- Improve learners' skills to write on topics of general interest and drafting correspondences for general purposes.

UNIT I		9

Listening - short video clips - conversational scenes form movies, celebrities' speeches /interviews. Speaking - several ways of introducing oneself at several situations, introducing others at several situations, inviting people for several occasions, describing people and their places. Reading - short comprehension passages - making inferences, critical analysis. Writing - completing the incomplete sentences - developing hints from the given information. Grammar - Wh-Questions and Yes or No questions - Parts of speech. Vocabulary development - prefixes - suffixes - articles - countable / uncountable nouns.

UNIT II		9

Listening - customer care voice files, short narratives - identifying problems and developing telephone etiquettes. Speaking - speaking over skype/ whatsapp, making business calls, making self-recorded informative videos, inquiring about a concept/activity, describing a concept/activity. Reading - reading the headlines on news magazines - slogans and taglines from advertisements. Writing - free writing - writing - headlines, slogans and taglines individual inspirations. Grammar- conjunctions, idioms, phrases, quotes. Vocabulary development - guessing the meanings of words in different contexts.

UNIT III		9

Listening - courtroom scenes from movies, debates and talks from news channels, notes taking. Speaking- language and tone for arguments, discussion, deliberation, contemplation, expressing opinions, reacting to different situations in an alien country. Reading - language used in instruction manuals of household appliances, cookery and other basic instructions. Writing- understanding the structure of texts - use of reference words, discourse markers- coherence, rearranging the jumbled sentences. Grammar - adjectives - degrees of comparison, framing direct and indirect questions. Vocabulary development - concise approach, single word substitution.

UNIT IV		9

Listening - Sports commentaries, advertisements with users' criticisms; Speaking - for social causes, for promoting a concept, negotiating and bargaining; Reading - review of a product, movie, movement or a system; Writing - writing for advertisements, selling a product; Grammar – Tenses - Simple Past, Present and Future, Continuous - Past, Present and Future; Vocabulary Development - synonyms, antonyms and phrasal verbs.

UNIT V		9

Listening - video lectures, video demonstration of a concept; Speaking – presenting papers/concepts, delivering short speeches, discourses on health, suggesting natural home remedies, cleanliness, civic sense and responsibilities; Reading - columns and articles on home science; Writing - correspondences of requests, basic enquiry/observation and basic complaints; Grammar - modal verbs, perfect tenses - Vocabulary development - collocations.

TOTAL PERIODS: 45

REFERENCE BOOKS	
1.	Department of English, Anna University, Mindscapes: English for Technologists and Engineers. Orient Black Swan, Chennai, 2017.
2.	Downes and Colm, " Cambridge English for Job-hunting ", Cambridge University Press, New Delhi, 2008.
3.	Murphy and Raymond, " Intermediate English Grammar with Answers " Cambridge University
4.	Press, 2000. Thomson, A.J., " Practical English Grammar 1 & 2" Oxford, 1986.
WEBSITES	
1.	http://www.usingenglish.com
2.	http://www.uefap.com3
3.	https://owl.english.purdue.edu/owl/
4.	www.learnenglishfeelgood.com/esl-printables-worksheets.html
SOFTWARES	
1.	Face 2 Face Advance – Cambridge University Press, 2014.
2.	English Advance Vocabulary- Cambridge University Press.
3.	IELTS test preparation – Cambridge University Press 2017
4.	Official Guide to the TOEFL Test with CD-ROM, 4th Edition.
5.	Cambridge Preparation for the TOEFL TEST- Cambridge University Press, 2017.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Acquire adequate vocabulary for effective communication.	3
2	Listen to formal and informal communication and read articles and infer meanings from specific contexts from magazines and newspapers.	3
3	Participate effectively in informal/casual conversations; introduce themselves and their friends and express opinions in English.	4
4	Comprehend conversations and short talks delivered in English.	6
5	Write short write-ups and personal letters and emails in English.	6

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1										3				
2										3				
3										3				
4										3			2	2
5										3			2	2

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

3 means ‘a strong correlation’ as the students will use all the four skills (Listening, Speaking, Reading and Writing) with appropriate body language in formal and informal environment.

MA22151	APPLIED MATHEMATICS I	LT P C
	(COMMON TO ALL BRANCHES EXCEPT MR)	3 10 4

COURSE OBJECTIVES

- Compute eigen values and eigen vectors and use in diagonalization and in classifying real quadratic forms.
- Study differential calculus and its applications to relevant Engineering problems.
- Compute derivatives using the chain rule or total differentials.
- Understand the rotation of two-dimensional geometry using definite integrals.
- Acquaint with the Mathematical tools needed in evaluating multiple integrals and their usage.

UNIT I	MATRICES	9+3

Eigen values and Eigen vectors of a real matrix – Characteristic equation – Properties of Eigen values and Eigen vectors – Statement and Applications of Cayley-Hamilton Theorem –Diagonalization of matrices– Reduction of a quadratic form into canonical form by orthogonal transformation-Nature of quadratic forms.

UNIT II	APPLICATION OF DIFFERENTIAL CALCULUS	9+3

Curvature and radius of Curvature– Centre curvature – Circle of curvature –Evolutes– Envelopes- Evolute as Envelope of Normals.

UNIT III	DIFFERENTIAL CALCULUS FOR SEVERAL VARIABLES	9+3

Limits and Continuity - Partial derivatives – Total derivatives – Differentiation of implicit functions – Jacobians and properties– Taylor's series for functions of two variables – Maxima and Minima of functions of two variables –Lagrange's method of undetermined multipliers.

UNIT IV	APPLICATION OF DEFINTE INTEGRALS	9+3

Integration by Parts-Bernoulli's formula for integration- Definite integrals and its Properties- Solids of Revolution- Disk Method- Washer Method- Rotation about both x and y axis and Shell method.

UNIT V	MULTIPLE INTEGRALS	9+3

Double integrals in Cartesian and polar coordinates – Change of order of integration – Area enclosed by plane curves - Change of variables in double integrals – Triple integrals – Volume of solids.

TOTAL (L:45+T:15) PERIODS: 60

TEXT BOOKS

1.	Erwin Kreyszing, Herbert Kreyszing, Edward Norminton, 'Advanced Engineering Mathematics', John Wiley, (2015), 10th Edition.
2.	Grewal B.S, Grewal J.S, "Higher Engineering Mathematics",43rdEdition, Khanna Publications, Delhi, (2015).

REFERENCE BOOKS

1.	Bali N.P and Manish Goyal, "A Text book of Engineering Mathematics", Nineth Edition, Laxmi Publications Pvt. Ltd., (2014).
2.	Glyn James, "Advanced Modern Engineering Mathematics", 4thEdition, Pearson Education, (2016).
3.	Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, (2013).

WEBLINKS	
1.	https://home.iitk.ac.in/~peeyush/102A/Lecture-notes.pdf
2.	https://www.sydney.edu.au/content/dam/students/documents/mathematics-learning-entre/integration-definite-integral.pdf

COURSE OUTCOMES

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

CO's	STATEMENTS	RBT LEVEL
1	Solve the Eigen value problems in matrices.	3
2	Apply the basic notion of calculus in Engineering problems and to tackle for different geometries.	3
3	Perform calculus for more than one variable and its applications in Engineering problems.	3
4	Apply definite integrals for design of three dimensional components.	3
5	Evaluate multiple integral in Cartesian and polar coordinates.	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3								3	3	3
2	3	3										3	2	2
3	3	3	3	3								3	2	2
4	3	3										3	2	2
5	3	3	2	2								3	2	2

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

PH22151	APPLIED PHYSICS	L T P C
	(COMMON TO AD, CS, EE, EC, IT)	3 00 3

COURSE OBJECTIVE

- To enhance the fundamental knowledge in Physics and its applications relevant to various Streams of Engineering and Technology.

UNIT I	LASERS AND FIBER OPTICS	9

Lasers: population of energy levels, Einstein's A and B coefficients derivation – resonant cavity, optical amplification (qualitative) – Nd-YAG laser – CO_2 Laser – Exceimer Laser – Applications. Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibres (material, refractive index, and mode) – losses associated with optical fibers–Fiber optic communication - fibre optic sensors: pressure and displacement - Endoscope.

UNIT II	QUANTUM PHYSICS	9

Black body radiation – Planck's theory (derivation)- deduction of Wien's and Rayleigh Jean's law – Compton effect: theory and experimental verification – wave particle duality – electron diffraction – concept of wave function and its physical significance – Schrödinger's wave equation – time independent and time dependent wave equations – particle in a one-dimensional - three dimensional potential box– Fermi distribution function – Effect of temperature on Fermi Function – Density of energy states – carrier concentration in metals.

UNIT III	CRYSTAL PHYSICS	9

Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – interplanar distances- coordination number and packing factor for SC, BCC, FCC, HCP and Diamond structure (qualitative) - crystal imperfections: point defects, line defects – Burger vectors, stacking faults.

UNIT IV	WAVES AND OSCILLATIONS	9

Travelling waves, Wave equation for string, Energy and momentum, Resonance Superposition & Reflection, Standing waves, Harmonic oscillations, Damped harmonic motion- Forced oscillations, amplitude resonance - Expression for Resonant frequency, Electrical analogy of mechanical oscillations, Quality factor and sharpness of resonance, Electrical analogy of mechanical oscillators.

UNIT V	ELECTROMAGNETIC WAVES	9

Maxwell's Equations. Vector and Scalar Potentials. Plane waves in Dielectric media. Poynting Theorem and Poynting Vector- Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, EM Wave Propagation in Unbounded Media, Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Gaur R.K., Gupta S.L, 'Engineering Physics', Dhanput Publications, 2015.
2.	Shatendra Sharma, Jyotsna Sharma, 'Engineering Physics', Pearson, 2006.
3.	Rajendran V, 'Engineering Physics', Tata McGraw Hill, 2009.
4.	Arumugam M, 'Materials Science', Anuradha Publications, 2015.

REFERENCE BOOKS	
1.	David Halliday, Robert Resnick, Jearl Walker, 'Principles of Physics', Wiley, 2015, 10th Edition.
2.	Peter Atkins, Julio De Paula, 'Physical Chemistry',Oxford University Press, 2014, 10th Edition.
3.	Arthur Beiser, Shobhit Mahajan, Rai Choudhury S, 'Concepts of Modern Physics', McGraw Hill Education, 2017, 7th Edition.
4.	Raghavan V, 'Materials Science and Engineering', PHI Learning Pvt. Ltd., 2010.

COURSE OUTCOMES

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

CO's	STATEMENTS	RBT LEVEL
1	Develop an understanding about photonics and Fiber Optic communication system.	2
2	Acquire the knowledge of Quantum mechanics.	3
3	Classify and demonstrate the fundamentals of crystals and their defects.	3
4	Gain knowledge in waves and oscillations.	2
5	Enable to explore the theory of electromagnetic waves and its propagation.	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3				2	2				1			2	2
2	3	3	2	2	2	2				1		2	2	3
3	3									1			2	2
4	3		2							1			3	3
5	3	3	2	2	2					1		2	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

CY22151	APPLIED CHEMISTRY	L T P C
	(COMMON TO AD, CS, EE, EC, IT)	3 0 0 3

COURSE OBJECTIVES

- To make the students conversant with basic electrochemistry and batteries.
- To develop an understanding of the laws of photochemistry and basics.
- To acquaint the students with the basics of nanomaterials, their properties and uses.
- To acquire the basic knowledge on sensors which are essential for the software engineers for develop new devices.
- To enable the students to understand the types of instruments for material analysis and their working principle.

UNIT I	ELECTROCHEMISTRY	9

Electrodes and electrochemical cells – electrode potential, standard electrode potential, single electrode potential and its determination, types of electrodes – calomel, quinhydrone and glass electrode. Nernst equation - Determination of pH of a solution by using quinhydrone and glass electrode. Electrochemical series and its applications. Batteries – Primary (dry cell) and secondary batteries (Lead – acid storage battery and Lithium ion battery) and next generation batteries.

UNIT II	PHOTOCHEMISTRY	9

Laws of photochemistry – Grotthuss-Draper law, Stark–Einstein law and Lambert Beer Law – determination iron by spectrophotometer. Quantum efficiency – Photo processes - internal conversion, inter-system crossing, fluorescence, phosphorescence and photo-sensitization-quenching of fluorescence and its kinetics, Stern-Volmer relationship. Applications of photochemistry.

UNIT III	NANOCHEMISTRY	9

Basics and scale of nanotechnology, different classes of nanomaterials, Distinction between molecules, nanoparticles and bulk materials; size-dependent properties. Synthesis of nanomaterials, fabrication (lithography) and its applications – Basics of nanophotonics and quantum confined materials (surface plasmon resonance).

UNIT IV	CHEMICAL SENSOR	9

Sensors, sensor science and technology, types of sensors. Chemical Sensors – characteristics and elements. Electrochemical sensors – voltammetry, potentiometric sensors, amperometric sensors, polarization techniques.

UNIT V	INSTRUMENTATION TECHNIQUES	9

Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental method - Electromagnetic radiation-UV-visible and IR spectroscopy: principles, instrumentation (Block diagram only) and applications. Separation techniques chromatography: Gas chromatography, liquid chromatography - importance of column technology (packing, capillaries), separation based on increasing number of factor (volatility, solubility, interactions with stationary phase, size).

TOTAL PERIODS: 45

TEXT BOOKS

1.	Jain P.C. and Monica Jain, 'Engineering Chemistry', Dhanpat Rai Publishing Company (P) Ltd., New Delhi, 2010.
2.	Dara S.S, Umare S.S, 'Engineering Chemistry', S. Chand & Company Ltd., New Delhi 2010.
3.	B.K.Sharma, 'Instrumental Methods of Chemical Analysis', Goel Publishing House, 2012,

	28th Edition,.
4.	Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.
REFERENCE BOOKS	
1.	Ozin G. A. and Arsenault A. C., 'Nanochemistry: A Chemical Approach to Nanomaterials', RSC Publishing, 2005.
2.	B.R. Puri, L.R. Sharma, M.S. Pathania., 'Principles of Physical Chemistry', Vishal Publishing Company, 2008.
3.	John Vetelino, Aravind Reghu, 'Introduction to Sensors', Taylor & Francis Group, CRC Press, 1st edition, 2010.
4.	Peter Gründler, 'Chemical Sensors, An Introduction for Scientists and Engineers', Springer-Verlag Berlin Heidelberg 2007.

COURSE OUTCOMES

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

COs	**STATEMENTS**	**RBT LEVEL**
1	Identify electrochemical cells, corrosion and fundamental aspects of batteries	2
2	Interpret the photochemical reactions and make use of spectroscopic techniques	2
3	Realize the structures, properties and applications of nanoparticles.	2
4	Acquire the basic knowledge on chemical sensors to develop an interdisciplinary approach among the students which are essential for the software engineers.	2
5	Develop a theoretical principles of UV-visible and IR spectroscopy and separation techniques.	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	2								3	3	3
2	3	3				3	3					3	2	2
3	3	3	3			3	3	1				3	3	3
4	3	3	3		1	3	3					3	2	2
5	3	3		2		3	3					3	2	2

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

CM22151	BASIC CIVIL AND MECHANICAL ENGINEERING	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To provide the students an illustration of the significance of the Civil and Mechanical Engineering Profession in satisfying the societal needs.
- To help students acquire knowledge in the basics of surveying and the materials used for construction.
- To provide an insight to the essentials of components of a building and the infrastructure facilities.
- To explain the component of power plant units and detailed explanation to IC engines their working principles.
- To explain the Refrigeration & Air-conditioning system.

UNIT I	PART A: OVERVIEW OF CIVIL ENGINEERING	5

Civil Engineering contributions to the welfare of Society - Specialized sub disciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering – National building code – terminologists: Plinth area, Carpet area, Floor area, Buildup area, Floor space index - Types of buildings: Residential buildings, Industrial buildings.

UNIT I	PART B: OVERVIEW OF MECHANICAL ENGINEERING	4

Overview of Mechanical Engineering - Mechanical Engineering Contributions to the welfare of Society – Specialized sub disciplines in Mechanical Engineering – Manufacturing, Automation, Automobile and Energy Engineering - Interdisciplinary concepts in Mechanical Engineering.

UNIT II	SURVEYING AND CIVIL ENGINEERING MATERIALS	9

Surveying: Objects – Classification – Principles – Measurements of Distances and angles – Leveling – Determination of areas– Contours.

Civil Engineering Materials: Bricks – Stones – Sand – Cement – Concrete – Steel - Timber – Modern Materials, Thermal and Acoustic Insulating Materials, Decorative Panels, Water Proofing Materials. Modern uses of Gypsum, Pre-fabricated Building component (brief discussion only)

UNIT III	BUILDING COMPONENTS AND INFRASTRUCTURE	9

Building plans – Setting out of a Building - Foundations: Types of foundations – Bearing capacity and settlement – Brick masonry – Stone Masonry – Beams – Columns – Lintels – Roofing Flooring – Plastering. Types of Bridges and Dams – Water Supply Network - Rain Water Harvesting – Solid Waste Management - Introduction to Highways and Railways - Introduction to Green Buildings.

UNIT IV	INTERNAL COMBUSTION ENGINES AND POWER PLANTS	9

Classification of Power Plants- Working principle of steam, Gas, Diesel, Hydro -electric and Nuclear Power plants- Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines. Working principle of Boilers-Turbines, Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps, Concept of hybrid engines. Industrial safety practices and protective devices.

UNIT V	REFRIGERATION AND AIR CONDITIONING SYSTEM	9

Principles of Refrigeration and Air Conditioning. Vapour compression and absorption system–Layout of typical domestic refrigerator–Window and Split type room Air conditioner. Tonnage calculations for refrigerator and air conditioning systems.

TOTAL PERIODS: 45

TEXT BOOKS	
1.	G Shanmugam, M S Palanichamy, 'Basic Civil and Mechanical Engineering', McGraw Hill Education; First edition, 2018.
2.	P.Selvaraj, M. Periyasamy, S. Selvakumar, 'Basic Civil and Mechanical Engineering', Scitech Publications Pvt. Ltd., 2013.
REFERENCE BOOKS	
1.	Palanikumar, K. 'Basic Mechanical Engineering', ARS Publications, 2018.
2.	Ramamrutham S., 'Basic Civil Engineering', Dhanpat Rai Publishing Co.(P) Ltd, 2013.
3.	Seetharaman S., 'Basic Civil Engineering', Anuradha Agencies, 2005.
4.	Shantha Kumar SRJ., 'Basic Mechanical Engineering', Hi-tech Publications, Mayiladuthurai, 2000.
5.	Nag P.K, 'Power Plant Engineering', Tata McGraw Hill Publishing Co., New Delhi, 2014.
6.	Ganesan V, 'Internal Combustion Engines', Tata McGraw Hill Publishing Co., New Delhi, 2012,4th edition,.
7.	Arora C.P, 'Refrigeration and Air Conditioning', Tata McGraw Hill Publishing Co, New Delhi, 2009.

COURSE OUTCOMES

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

CO's	STATEMENTS	RBT LEVEL
1	Summarise the importance of Civil and Mechanical engineering towards the welfare of society.	2
2	Apply the principles and the different methods of surveying and discuss the properties and uses of various construction materials.	3
3	Describe about the building components and common infrastructures.	2
4	Explain about the various power plants and the working principles of internal combustion engines used in automotive vehicles.	2
5	Elaborate the working of domestic refrigerator and air conditioners.	2

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3					3		3					2	2
2	3					3		3					2	2
3	3					3		3					2	2
4	3					3		3					2	3
5	3					3		3					2	2

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

IT22101	PROGRAMMING FOR PROBLEM SOLVING	L T P C
	(COMMON TO IT, AD, CS, EE, EC)	3 00 3

COURSE OBJECTIVES

- Learn the organization of a digital computer.
- Learn to think logically and write algorithms or draw flow charts for problems.
- Be exposed to the syntax of C.
- Be familiar with programming in C.
- Learn to use arrays, strings, functions, pointers, structures and unions in C.

UNIT I	INTRODUCTION TO PROBLEM SOLVING	6

Simple model of a Computer – Hardware – Software – Data Representation, Introduction to Computer Networks and Internet, Problem Solving Techniques – Bottom up design and top down design - applications, Introduction to Algorithms and Flow Chart.

Suggested Activities:

Case study – Understanding the analysis and design of the Student Management System (SMS).

UNIT II	C PROGRAMMING BASICS	12

Introduction to 'C' programming – structure of a 'C' program – Conversion of simple algorithm to program. Constants, Variables – Data Types – Expressions using operators in 'C' – Managing Input and Output operations – Decision Making and Branching – Looping statements – solving simple scientific and statistical problems.

Suggested Activities:

Case study: Dataset creation and Grade calculation in SMS.

UNIT III	ARRAYS AND STRINGS	9

Array: declaration, initialization. Multi dimensional arrays. Strings: Strings vs Character arrays, string operations.

Suggested Activities: Grade sheet generation in SMS.

UNIT IV	FUNCTIONS AND STRUCTURES	9

Need for Modular programming, Functions: definition, call, arguments, call by value. Call by reference, Recursion. structures and unions: Need, declaration, Accessing Structure elements, Arrays of structures

Suggested Activities: Redesigning SMS in terms of modules.

UNIT V	POINTERS AND FILE HANDLING IN C	9

Pointers: Introduction, pointers to primitive datatypes, pointers to user defined datatypes: arrays and structures, array of pointers, Dynamic Memory Allocation. Files: Read/Write of binary and text files. Preprocessor directives.

Suggested Activities: Mange I/O in SMS using Files.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Pradip Dey, Manas Ghosh, 'Programming in C', Oxford University Press, 2018, 1st Edition.
2.	R G Dromey, "How to Solve it using Computer", Pearson,2006.

REFERENCE BOOKS

1.	Kernighan,B.W and Ritchie,D.M, "The C Programming language", Pearson Education, 2015, 2nd Edition,.
2.	Yashavant P. Kanetkar. "Let Us C", BPB Publications, 2011.
3.	Byron S Gottfried, "Programming with C", Schaum's Outlines, Tata McGrawHill, 2010,

	3rd Edition.
4.	Reema Thareja, "Programming in C", Oxford University Press, 2016, 2nd Edition.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Identify input and output from the real word problem scenarios.	3
2	Represent the design flow using Flow-charts and application logic using pseudo code.	3
3	Apply appropriate programming constructs to implement a given design using C.	3
4	Debug and customize an existing software developed in C.	5
5	Develop a modularised software application In C for the given user requirements	6

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	1	3						2	3			2	3	3
2	1	3						2	3			2	3	3
3	1		3	2	1			2	3			2	3	3
4	1		3	2	1			2	3			2	3	3
5	1		3	2	1			2	3			2	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22111	BASIC ELECTRICAL & ELECTRONICS ENGINEERING LABORATORY	L T P C
	(COMMON TO ALL BRANCHES EXCEPT EC)	0 02 1

COURSE OBJECTIVES

- To provide exposure to the students with hands on experience in basic of Electrical and Electronics wiring connection and measurements.
- To introduce the students to Electrical Machines and basic laws of Electrical Circuits.

LIST OF EXPERIMENTS	
1.	Wiring – Residential house wiring and Stair case wiring.
2.	(a) AC Analysis- Measurement of electrical quantities–voltage, current, power, and power factor using RLC. (b) Study of three phase system.
3.	Energy conservation - Measurement and comparison of energy for incandescent lamp and LED lamp.
4.	(a) Identification of circuit components (Resistor, Capacitor, Diode and BJT) and soldering practice. (b) Signal Measurement- Measurement of peak to peak, RMS, average, period, frequency of signals using CRO.
5.	(a) VI Characteristics of Solar photovoltaic panel. (b) Design of Solar PV Array and Battery sizing for Residential solar PV system.
6.	Design a 5V/12V Regulated Power Supply using FWR and IC7805 / IC7812.
7.	DC Analysis- Verification of Ohm's Law and Kirchhoff's Laws.
8.	Study of Transformer and motor characteristics.
	TOTAL PERIODS:30

REFERENCE BOOKS

1.	Mittle V.N, Arvind Mittal, 'Basic Electrical Engineering', Tata Mc Graw Hill (India), 2013, 2nd Ediiton.
2.	Sedha R.S., 'A Text Book of Applied Electronics', S.Chandand Co., 2014.

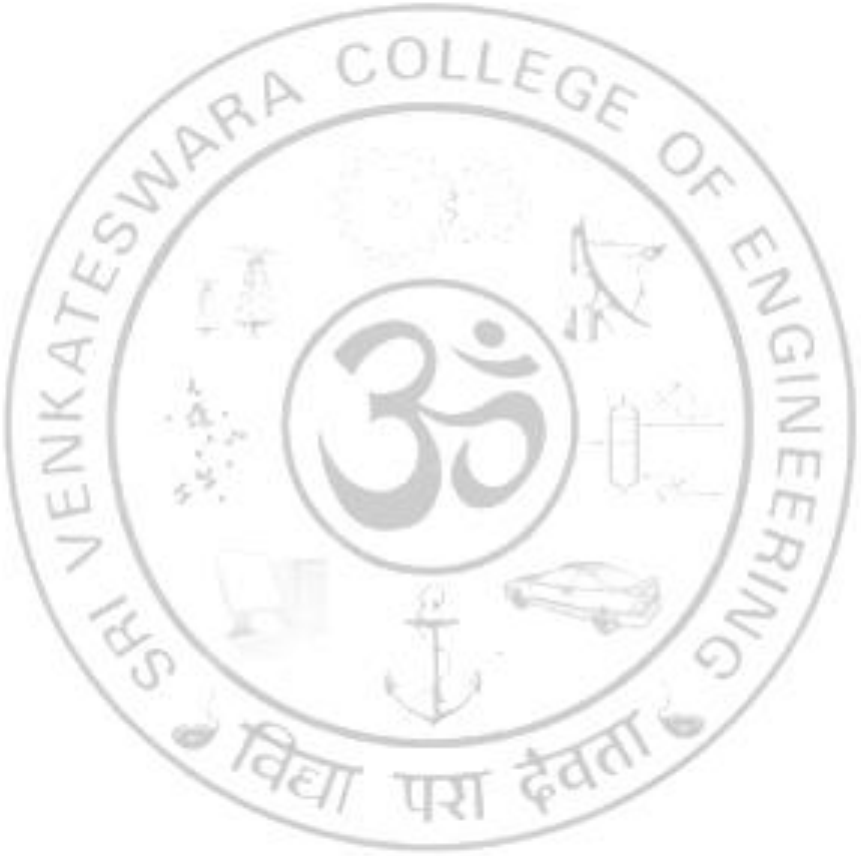
COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Wiring of basic electrical system and measurement of electrical parameters.	4
2	Verify the basic laws of Electric circuits and select various Electrical Machines.	4
3	Construct electronic circuits and design solar photovoltaic system.	4
4	Apply the concept of three-phase system.	4
5	Construct a fixed voltage regulated power supply.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3					2			2	3	3
2	3	3	3	3					2			2	3	3
3	3	3	3	3					2			2	3	3
4	3	3	3	3					2			2	3	3
5	3	3	3	3					2			2	3	3
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														



ME22161	BASIC CIVIL AND MECHANICAL ENGINEERING LABORATORY	L T P C
	(COMMON TO CE, EE, EC)	0 0 2 1

COURSE OBJECTIVES

- To provide an exposure and hands on experience to the students on various civil and mechanical engineering processes.

LIST OF EXPERIMENTS

1.	Carpentry – Preparation of Cross half lap joint and Tee joint using power tools.
2.	Plumbing – Basic pipe line connection used in houses with PVC pipes, valves, taps, couplings, unions, reducers, elbows.
3.	Welding - Butt joint and lap joint using Electric Arc welding.
4.	Machining – Turning and facing using Centre Lathe.
5.	Sheet metal work – Making of a cylinder using GI sheet and finishing using rivets.
6.	Fitting – Preparation of metal pieces by grinding and filing to maintain flat sides at right angles.
7.	Drilling and Tapping – Drilling of holes precisely and making internal threads by Tapping for various sizes.
8.	Casting – Mould preparation using simple solid pattern and casting.
9.	Automation – Basic pneumatic circuit using single and double acting cylinder.
10	3D printing –Demonstration of printing of simple solids using Additive Manufacturing/3D printing.

TOTAL PERIODS:30

TEXT BOOKS

1.	Jeyachandran K., Natarajan S. and Balasubramanian S., 'A Primer on Engineering Practices Laboratory', Anuradha Publications, 2007.
2.	Jeyapoovan T., Saravanapandian M. and Pranitha S., 'Engineering Practices Lab Manual', Vikas Publishing House Pvt.Ltd, 2006.
3.	Bawa H.S., 'Workshop Practice', Tata McGraw Hill Publishing Company Limited, 2007.
4.	Ian Gibson, David W Rosen, Brent Stucker., 'Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing', Springer, 2010.
5.	Anthony Esposito, 'Fluid Power with Applications', Pearson Education, 2009, 7thEdiiton.
6.	Civil and Mechanical Engineering Practices Lab Manual, SVCE, 2022.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Prepare various joints used for assembling wooden parts	3
2	Make required pipeline connection by selecting the suitable components	3
3	Fabricate components by various manufacturing processes	3
4	Understand the principles of low-cost automation using pneumatic circuits	2
5	Understand the principle of additive manufacturing/3D printing	2
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2												2	2
2	2												2	2
3	2												2	2
4	1				2								2	2
5	1				2								2	2

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

IT22111	PROGRAMMING FOR PROBLEM SOLVING LABORATORY	L T P C
	(COMMON TO IT, AD, CS, EE, EC)	0 0 3 1.5

COURSE OBJECTIVES

- Be exposed to the syntax of C.
- Be familiar with programming in C.
- Learn to use arrays, strings, functions, pointers, structures and unions in C.

LIST OF EXPERIMENTS	
1.	Usage of Basic Linux commands.
2.	C Programming using Simple statements and expressions.
3.	Scientific problem solving using decision making and looping.
4.	Simple programming for one dimensional and two dimensional arrays.
5.	Solving problems using Strings.
6.	C Programming using Pointers.
7.	C Programming using user defined functions (Pass by value and Pass by reference).
8.	C Programming using Recursion.
9.	C Programming using structures and union.
10.	C Programming using enumerated data types.
11.	C Programming using macros and storage classes.
12.	C Programming using Files.
13.	Develop modularized application for any one of the following scenarios.
	Scenarios: o Student Management System o Stock Management System o Banking Application o Ticket Reservation System
	TOTAL PERIODS:45

TEXT BOOKS

1.	Pradip Dey, Manas Ghosh, 'Programming in C', Oxford University Press, 2018, 1st Ediiton.
2.	Byron S Gottfried, "Programming with C", Schaum's Outlines, Third Edition, Tata McGrawHill, 2010.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Apply appropriate programming constructs to solve problems	3
2	Design, implement, test and debug programs that use the basic features of C	5
3	Design modularized applications in C to solve real world problems	6
4	Use C pointers and dynamically allocated memory to solve complex problems	4
5	Apply file operations to develop solutions for real-world problems	3
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	1	3						2	3			2	3	3
2	1	3						2	3			2	3	3
3	1		3	2	1			2	3			2	3	3
4	1		3	2	1			2	3			2	3	3
5	1		3	2	1			2	3			2	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

SEMESTER II

HS22251அறிவியல் மற்றும் தொழில் நுட்பத்தில் தமிழ் L T P C

Science and Technology in Ancient Tamil Society **2 0 02**

(*COMMON TO ALL BRANCHES*)

பாடத்தின்நோக்கங்கள் :

- அறிவியலில் தமிழின் பயன்பாடு பற்றி தெரிந்து கொள்வார்கள்.
- தொழில்நுட்பத்தில்தமிழ் பாரம்பரியத்தின் தாக்கம் பற்றிஅறிந்துகொள்வார்கள்.

Course Objectives:

- They will know about the use of Tamil in science.
- Learn about the impact of Tamil heritage on technology.

அலகு 1 அறிவியல் தமிழ் : 3

கருவி உருவாக்கம் - ஆராய்ச்சி மேம்பாடு - கல்வி வளர்ச்சி - அறிவியல் தமிழ் சொற்கள் உருவாக்கம்.

UNIT I Scientific Tamil

Tool Development - Research Development - Educational Development - Scientific Tamil words Creation.

அலகு 2 தொழில் நுட்பத்தில் தமிழ் 12

வடிவமைப்பு மற்றும் கட்டுமான தொழில்நுட்பம் :சங்க காலத்தில் கட்டுமானப் பொருட்கள் - சோழர்களின் பெரிய கோவில்கள் மற்றும் பிற வழிபாட்டு தலங்கள் - பல்லவர்களின் சிற்பங்கள் மற்றும் கோவில்கள் (மாமல்லபுரம்) - நாயக்கன் கால கோவில்கள் (மதுரை மீனாட்சி அம்மன் கோவில்), திருமலை நாயக்கர் மஹால், செட்டி நாட்டு வீடுகள்.

UNIT II Tamil in Technology

Design and Construction Technology: Building materials in Sangam age – Great temples of Cholas and other workship places – Sculptures and Temples of Pallavas (**Mamallapuram**) – Temples of Nayakas period (**Madurai Meenakshi amman temple**), Thirumalai Nayakar Mahal, Chetti Nadu Houses.

உற்பத்தி தொழில்நுட்பம் :கப்பல் கட்டும் கலை, உலோகவியல் ஆய்வுகள், தங்கம், தாமிரம், இரும்பு பற்றிய அறிவு - தொல்பொருள் சான்றுகள் – சுட்டக்களிமண் மணிகள், சங்கு மணிகள், எலும்பு மணிகள்.

Manufacturing Technology: Art of Ship building, Metallurgical studies,Knowledge about Gold, Copper, Iron – Archeological evidences – Terracotta beads, Shell beads, Bone beads.

விவசாயம் மற்றும் நீர்ப்பாசன தொழில்நுட்பம் : அணைகள், ஏரிகள், குளங்கள், மதகுகள், சோழர் கால குமுழி தூம்பு ஆகியவற்றின் முக்கியத்துவம் - கால்நடை பராமரிப்பு, கால்நடைகளின் பயன்பாட்டிற்காக வடிவமைக்கப்பட்ட கிணறுகள். விவசாயம் மற்றும் வேளாண் செயலாக்கம் - கடல் பற்றிய அறிவு - மீன்பிடித்தல், முத்து குளித்தல், சங்கு சேகரித்தல்.

Agriculture and Irrigation Technology: Dams, Tank, ponds, sluice, Significance of KumuzhiThoompu of Cholas period- Animal Husbandry, Wells designed for cattle use. Agriculture and Agro processing, - Knowledge about Sea – Fisheries, Pearl, Conche diving.

தமிழ் கணினி: அறிவியல் தமிழ் வளர்ச்சி - தமிழ் கணினி, தமிழ் புத்தகங்களின் டிஜிட்டல் மயமாக்கல், தமிழ் டிஜிட்டல் நூலகம், தமிழ் மென்பொருள் உருவாக்கம் - தமிழ் மெய்நிகர் அகாடமி - சொற்குவை திட்டம்.

Tamil Computing: Development of Scientific Tamil – Tamil Computing, Digitization of Tamil books, Tamil Digital Library, Development of Tamil Softwares – Tamil virtual Academy – Sorkuvai project.

தமிழின் எதிர்காலமும் தகவல் தொழில்நுட்பமும்- உலகமயமாக்கலும் தகவல் தொழில்நுட்பமும்-கணினிக்கு தமிழ் கற்று கொடுத்தல்-தமிழ் மொழித் தொழில்நுட்பத்தில் வளங்கள்.

Future of Tamil and Information Technology- Globalization and Information Technology-Teaching Tamil for Computer-Resources in Tamil Language Technology.

பாடநெறி முடிவுகள் :

பா .வெ . எண்	பாடத்திட்டத்தின் வெளிப்பாடு	RBT level
CO 1	அறிவியலில் தமிழ் மொழியின் பயன்பாடு பற்றி தெரிந்து கொள்வார்கள்	2
CO 2	பல்வேறு தொழில்நுட்பத்தில் தமிழ் மொழியின் தாக்கம் பற்றி அறிந்து கொள்வார்கள்	3

பாட நூல்கள்:

1.**டாக்டர், வா.செ .குழந்தைசாமி (1985),**"அறிவியல் தமிழ் ", பாரதி பதிப்பகம், 126/108, உஸ்மான் சாலை, தியாகராய நகர் , சென்னை 600017

2.**சுப. திண்ணப்பன், (1995),** "கணினியும் தமிழ் கற்பித்தலும்", புலமை வெளியீடு, 38-B மண்ணத்நதோட்டத் தெரு, ஆழ்வார்பேட், சென்னை 600018

3.**மு. பொன்னவைக்கோ, (2003),** "வளர் தமிழில் அறிவியல் – இணையத்தமிழ்", அனைத்திந்திய அறிவியல்தமிழ்க்கழகம், தஞ்சாவூர் 615 005.

4.**துரை. மணிகண்டன், (2008),** "இணையமும் தமிழும்", நல் நிலம் பதிப்பகம், 7-3, சிமேட்லி சாலை, தியாகராய நகர், சென்னை 600 017.

HS22252	TECHNICAL ENGLISH	L T P C
	(COMMON TO ALL BRANCHES)	3 0 0 3

COURSE OBJECTIVES

- Enable learners to define and understand technical communication and scientific writing
- Expose learners to the technicalities of seminar presentation, group discussion, and public speaking
- Develop learners' writing skills for scientific and documenting purposes
- Improve learners' ability to draft correspondences for business purposes
- Cultivate learners' ability to holistically understand the nuances of job interviews and recruiting process.

UNIT I		**9**

Listening - AV files pertaining to manufacturing processes of products, scientific documentaries; Speaking - syllable division and word stress, intonation, sharing opinions; Reading - news articles related to science and technology; Writing - definitions, instruction, recommendation, data interpretation, resume; Grammar - tenses and their aspects, sentence connectors – discourse markers, sequential words, active and passive voice, subject-verb agreement.

UNIT II		**9**

Listening - AV pertaining to marketing strategies, peer reading and pronunciation; Speaking- turn taking, sharing opinions; conducting and attending a meeting, understanding the nuances of spoken communication among internal audience and external audience; Reading - analytical documents, descriptive documents; Writing - fliers, brochures, resume - letter of application, checklists; Grammar - modal verbs, clauses - types and uses, conditional clauses, articles.

UNIT III		**9**

Listening - AV related to how to use components, scientific description, Speaking - speaking for motivation and initiation, speaking at a seminar presentation; Reading - scientific journals, papers; Writing - Technical descriptions - process description, purpose and function, PowerPoint, Google forms, user manuals; Grammar - phrasal verbs, prepositions, technical and scientific affixes.

UNIT IV		**9**

Listening - scientific debates, crisis management; Speaking - handling conflicts, speaking about the loss of benefits, progress or decline of business, identifying the connotative meanings, Reading- documented evidences of uses and functions of a product, review of a product, Writing - memos, follow-up letters, reports - proposal, project, progress reports, sales reports, reports on industrial visits, executive summary. Grammar - reported speech and tag questions, sentence structure - comparative, imperative, cause and effect, infinitive of result.

UNIT V		**9**

Listening - AV of Group discussions, panel discussions, face to face interviews for recruitment purposes; Speaking- speaking at group discussions, interviewing a personality, answering at the interviews; Reading - WebPages of top notch engineering companies, Writing - blogging, e-mails, letter of complaint, minutes of the meeting; Grammar - one word substitution, collocations, better word/sentence substitution (rephrasing the content/improvising ideas).

TOTAL PERIODS: 45

REFERENCE BOOKS	
1.	Department of English, Anna University. Mindscapes: English for Technologists and Engineers. Orient Blackswan, Chennai. 2012.
2.	Downes, Colm, Cambridge English for Job-hunting, Cambridge University Press, New Delhi. 2008.
3.	Murphy, Raymond, Intermediate English Grammar with Answers, Cambridge University Press 2000.
4.	Thomson, A.J., Practical English Grammar 1 & 2, Oxford, 1986.
5.	Herbert A J, The Structure of Technical English, Longman, 1965.
WEBSITES	
1.	http://www.usingenglish.com
2.	http://www.uefap.com3
3.	https://owl.english.purdue.edu/owl/
4.	www.learnenglishfeelgood.com/esl-printables-worksheets.html
SOFTWARES	
1.	Face 2 Face Advance – Cambridge University Press, 2014.
2.	English Advance Vocabulary- Cambridge University Press.
3.	IELTS test preparation – Cambridge University Press 2017.
4.	Official Guide to the TOEFL Test with CD-ROM, 4th Edition.
5.	Cambridge Preparation for the TOEFL TEST- Cambridge University Press, 2017.

COURSE OUTCOMES

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

CO's	STATEMENTS	RBT LEVEL
1	Understand the nuances of technical communication and scientific writing	3
2	Present papers and give seminars	3
3	Discuss in groups and brainstorm	6
4	Draft business correspondences and write for documenting purposes	6
5	Face job interviews with confidence	6

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1										3			2	2
2										3				
3										3			2	2
4										3			2	2
5										3			2	2

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

3 denotes ‘a strong correlation’ as the students will use all the four skills (Listening, Speaking, Reading and Writing) with appropriate body language in technical and professional situations.

MA22251	APPLIED MATHEMATICS II	L T P C
	(COMMON TO ALL BRANCHES EXCEPT MR)	3 1 0 4

COURSE OBJECTIVES

- Acquire the concepts of vector calculus needed for problems in all engineering disciplines and compute different types of integrals using Green's, Stokes' and Divergence theorems.
- Skilled at the techniques of solving ordinary differential equations that model engineering problems.
- Extend their ability of using Laplace transforms to create a new domain in which it is easier to handle the problem that is being investigated.
- Explain geometry of a complex plane and state properties of analytic functions.
- Understand the standard techniques of complex variable theory so as to apply them with confidence in application areas such as heat conduction, elasticity, fluid dynamics and flow of electric current.

UNIT I	VECTOR CALCULUS	9+3

Gradient, divergence and curl - Directional derivative - Vector identities – Irrotational and solenoidal vector fields - Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's theorem in a plane, Gauss divergence theorem and Stokes'theorem (excluding proofs) – Verification and application in evaluating line, surface and volume integrals.

UNIT II	ORDINARY DIFFERENTIAL EQUATIONS AND ITS APPLICATIONS	9+3

Differential equations of first order – Equations of the first order and first degree – Linear equations – Higher order linear differential equations with constant coefficients - Method of variation of parameters - Cauchy's and Legendre's linear equations - Simultaneous first order linear equations with constant coefficients – Applications of Linear differential equations – Oscillatory electrical circuit – Deflection of beams.

UNIT III	LAPLACE TRANSFORM	9+3

Conditions for existence - Transform of elementary functions - Transforms of unit step function and impulse functions – Basic properties – Shifting theorems - Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Initial and final value theorems - Transform of periodic functions. Inverse Laplace transforms - Convolution theorem – Application to solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

UNIT IV	ANALYTIC FUNCTIONS	9+3

Analytic functions - Necessary and sufficient conditions (Cauchy-Riemann equations) - Properties of analytic function - Harmonic conjugates - Construction of analytic functions - Conformal mapping – Mapping by functions W = Z + C, CZ, 1/Z, Z2 – Joukowski's transformation- Bilinear transformation.

UNIT V	COMPLEX INTEGRATION	9+3

Cauchy's integral theorem - Cauchy's integral formula - Taylor's and Laurent's series expansions - Singular points - Residues - Cauchy's Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semi-circular contour.

TOTAL (L:45+T:15) PERIODS: 60

TEXT BOOKS

1.	Erwin Kreyszing, Herbert Kreyszing, Edward Norminton, 'Advanced Engineering Mathematics', John Wiley, (2015), 10th Edition.

2.	Grewal B.S, Grewal J.S, "Higher Engineering Mathematics",43rdEdition, Khanna Publications, Delhi, (2015).
REFERENCE BOOKS	
1.	Dass, H.K., and Rajnish Verma, 'Higher Engineering Mathematics', S.Chand Private Ltd., 2011.
2.	Ramana B.V, 'Higher Engineering Mathematics', Tata McGraw Hill Publishing Company, New Delhi, (2013).
3.	Bali N. P and Manish Goyal, 'A Text book of Engineering Mathematics',Laxmi Publications(p) Ltd., 2014, 9thEdiiton.
WEB LINKS	
1.	https://nptel.ac.in/courses/111/105/111105134/
2.	https://nptel.ac.in/courses/111/105/111105121/

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Interpret the fundamentals of vector calculus and execute evaluation of line, surface and volume integrals using Gauss, Stokes and Green's theorems	3
2	Solve first order linear, homogeneous differential equations and use series solution method to solve second order differential equations	3
3	Determine the methods to solve differential equations using Laplace transforms and Inverse Laplace transforms	3
4	Explain Analytic functions and Categorize transformations	3
5	Perform Complex integration to evaluate real definite integrals using Cauchy integral theorem and Cauchy's residue theorem	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs											PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	2								3	3	3
2	3	3	3	3								3	3	3
3	3	3	3	3								3	3	3
4	3	3										3	3	3
5	3	3										3	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

PH22252	PHYSICS OF MATERIALS	L T P C
	(COMMON TO EE and EC)	3 0 0 3

COURSE OBJECTIVES

- To understand the physical properties of materials like electrical and thermal conductivity.
- To understand various types of semiconducting materials, their applications in the field of Engineering and understand the concept of Fermi energy.
- To understand the different types of dielectric materials and their applications in Engineering fields.
- To understand the phenomena of superconductor, properties and their applications and the different types of magnetic materials.
- Ability to understand different types of Transistors and its characteristics and to construct Basic Logic Gates and simplification of circuits using K-map.

UNIT I	CONDUCTING MATERIALS	9

Introduction – Classification of materials based on the electrical resistivity - Classical Free electron theory – Electrical and thermal conductivity of metal (derivation) – Wiedemann – Franz law – Lorentz number – Drawbacks of Classical Free electron theory – Quantum Free electron theory – Fermi distribution function – Effect of temperature of Fermi function – Density of energy states (derivation) – Carrier concentration in metals – Emission of electrons from metals – Thermionic emission – Photoelectric emission – Field emission.

UNIT II	SEMICONDUCTING MATERIALS	9

Introduction – Classification of materials based on band theory (metals, semiconductors and insulators) – Intrinsic and extrinsic semiconductors – Carrier concentration in intrinsic semiconductor (derivation) - Effect of temperature on Fermi level - Compound semiconductors – Variation of electrical conductivity in intrinsic semiconductors with temperature - Band gap determination of intrinsic semiconductor (derivation and Experiment to determine Band Gap) – Hall effect (derivation and experiment).Tunnel diode, Schottky diode.

UNIT III	DIELECTRIC PROPERTIES OF MATERIALS	9

Introduction to dielectric materials - Dielectric constant - Polarization of dielectric materials - Types of Polarization (Polarisability) - Equation of internal fields in solid (One- Dimensional) (Derivation) - Clausius – Mossotti Relation for elemental dielectric materials - Dielectric Breakdown - Frequency dependence of dielectric constant, Dielectric Losses - Important applications of dielectric material - Ferro and Piezo electricity (Qualitative).

UNIT IV	MATERIALS AT LOW TEMPERATURE AND MAGNETIC PROPERTIES	10

Temperature dependence of resistivity in superconducting materials - Meissner effect – Properties of superconductors - Type I and Type II superconductors - BCS theory (Qualitative) – Low Tc and High Tc (alloy) superconductors – Ceramic superconductors (oxide superconductors) - LaBaCuO, YBaCuO, BiSrCaCuO - Josephson's effect (AC and DC) – - Applications of Superconductors-SQUIDS – CRYOTRON – MAG LEV.

Dia, Para and Ferro magnetic material – Domain theory for Ferro magnetic materials - Phenomena of Hysteresis and its applications –Magnetic Semiconductor- Ferrites and its structures.

UNIT V	FUNDAMENTALS OF ELECTRONIC SCIENCE	8

JFET-Drain and Transfer Characteristics- Electronic Transistor (SET), Spintronics-Electronic devices vs Spintronic Devices-Design of Basic Logic gates using transistor, Karnaugh map SoP and PoS forms.

	TOTAL PERIODS: 45
TEXT BOOKS	
1.	Arumugam M, 'Materials Science', Anuradha Publications, 2015.
2.	Rajendran V, 'Engineering Physics', Tata McGraw Hill, 2015.
3.	Suresh R, Jayakumar V, 'Materials Science', Lakshmi Publications 2003.
4.	Palanisamy P.K, 'Materials Science', SciTech publications, 2015.
5.	V.K. Mehta, Rohit Mehta, 'Principles of Electronics"' 2020
6.	M. Morris Mano, 'Digital Design', Pearson Education, 2014, 3rd Edition.
REFERENCE BOOKS	
1.	Gaur R.K, Gupta S.L, 'Engineering Physics', Dhanpat Publications, 2015.
2.	Avadhnaulu M.N, Kshirsagar P.G, 'A Textbook of Engineering Physics', S. Chand, 2006.
3.	Kittel C, 'Introduction to Solid State Physics', Wiley Eastern Ltd, 2004, 7thEdiiton.
4.	Azaroff L.V, Brophy J.J., 'Electronic Processes in Materials', McGraw Hill.,1963.
5.	A.B. Gupta, Nurul Islam, 'Solid State Physics and Electronics', 2017.
6.	John F. Wakerley, 'Digital Design-Principle and practice', Pearson, 2008, 3rd Edition.

COURSE OUTCOMES

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

COs	**STATEMENTS**	**RBT LEVEL**
1	Comprehend the behavior of electrons in solids	2
2	Demonstrate an understanding of various properties of Semiconducting materials and their internal structure	3
3	Analyse the properties of dielectric materials and apply them in various fields	3
4	Summarize basics of magnetism and superconductivity. Explore a few of their technological applications	2
5	Develop an understanding the Fundamentals of Electronic Science and its applications	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3			1						1		2	3	3
2	3									1		2	3	3
3	3									1		2	3	3
4	3	2	2	1	2				2	1		2	3	3
5	3	2	2	1		2			2	1		2	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

ME22252	FUNDAMENTALS OF ENGINEERING GRAPHICS	L T P C
		2 0 2 3

COURSE OBJECTIVES

- This course will introduce students to build their ability to read drawings and interpret the position and form of simple geometries.
- This course will familiarize the students in drafting drawings with CAD software.

UNIT 0	CONCEPTS AND CONVENTIONS (NOT FOR EXAM)	2

Importance of graphics in engineering applications - Use of drafting instruments - BIS conventions and specifications - Size, layout and folding of drawing sheets - Lettering and dimensioning.

UNIT I	CONICS, CYCLOIDAL CURVES, AND INVOLUTES	7

Geometric construction - Curves used in engineering practices: Conics - Construction of ellipse, parabola and hyperbola by eccentricity method - Drawing of tangents and normal to the above curves - Construction of cycloid, epicycloid and hypocycloid - Drawing of tangents and normal to the above curves. Construction of involutes of square, pentagon and circle - Drawing of tangents and normal to the above involutes.

UNIT II	PROJECTION OF POINTS, LINES AND PLANE SURFACES	9

Orthographic projection – principles - Principal planes - First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method.

Projection of planes (polygonal and circular surfaces) inclined to one of the principal planes and perpendicular to other by rotating object method.

UNIT III	PROJECTION OF SOLIDS	9

Projection of simple solids like prisms, pyramids, cylinder, cone when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. Projections of hollow prism and hollow cylinder with centrally drilled hole or square through its ends by rotating line method - axis is inclined to one of the principal planes and parallel to the other.

UNIT IV	BLOCK FLOW DIAGRAM USING CAD	9

Introduction to Computer Aided Drafting hardware - Overview of application software -2D drafting commands (AutoCAD) for simple shapes – Schematic components in electrical systems – Connectors, Point to Pint Wiring diagrams – Terminals – Dimensioning and Plotting.

UNIT V	ORTHOGRAPHIC AND ISOMETRIC VIEWS USING CAD	9

Annotation in CAD - Isometric views - Orthographic views - 3D Modelling basics - 3D to 2D conversion.

TOTAL (30L+30P) PERIODS: 60

TEXT BOOKS

1.	Bhatt N.D. and Panchal V.M., 'Engineering Drawing', Charotar Publishing House,2019, 53rd Edition.
2.	Dhananjay M. Kulkarni, A.P. Rastogi, Ashoke K. Sarkar, 'Engineering Graphics with AutoCAD', PHI Learning Private Ltd., 2009.
3.	Venugopal K. and Prabhu Raja V., 'Engineering Drawing + AutoCAD', New Age International (P) Limited, 2022, 6thEdiiton.

REFERENCE BOOKS	
1.	Dhananjay A Jolhe, 'Engineering Drawing with an Introduction to AutoCAD', Tata McGraw-Hill Publishing Company Limited., 2008.
2.	Parthasarathy N. S. and Vela Murali, 'Engineering Graphics', Oxford University, Press, New Delhi, 2015.
3.	Shah M.B., and Rana B.C., 'Engineering Drawing', Pearson Education India, 2nd Edition, 2009.
4.	Natrajan K.V., 'A Text Book of Engineering Graphics', Dhanalakshmi Publishers, Chennai, 2018.
5.	Sham Tickoo, 'AutoCAD Electrical 2019 for Electrical Control Designers', Cadcim Technologies, 2019.
WEB LINKS	
1.	AutoCAD tutorials - https://www.thesourcecad.com/autocad-tutorials/
2.	https://nptel.ac.in/courses/112105294
3.	https://nptel.ac.in/courses/112103019

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Construct conic sections and as per drawing standards	2
2	Obtain orthographic projections of lines and plane surfaces and simple solids in various positions	3
3	Obtain projections of simple and hollow solids	3
4	Employ the CAD software for drafting and modelling of simple components	2
5	Construct 2D views from 3D models using CAD software	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1										1			2	2
2										2			2	2
3										2			2	2
4					2				1	3			2	2
5					2				1	3			2	2

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22201	ELECTRIC CIRCUIT ANALYSIS	L T P C
		3 1 0 4

COURSE OBJECTIVES

- To familiarize the principles of passive circuit elements and analyze circuit parameters.
- To solve complex circuits using network theorems and reduction methods.
- To impart knowledge on analysis of 3 phase circuits and its phasor diagrams.
- To analyze the transient response of circuits with DC and AC input.
- To introduce the phenomenon of resonance in coupled circuits.

UNIT I	BASIC CIRCUITS ANALYSIS	12

Ohm's Law – Kirchoff's laws – DC and AC Circuits – Resistors, Inductances and Capacitances in series and parallel – Mesh, Super mesh, Node and Super node method of analysis for DC and AC circuits - Dependent voltage and current sources.

UNIT II	NETWORK REDUCTION AND THEOREMS FOR DC AND AC CIRCUITS	12

Network reduction: Voltage and Current division, Source transformation – Star delta conversion, Thevenin's and Norton's Theorems – Superposition Theorem – Maximum power transfer theorem – Millman's theorem – Reciprocity Theorem.

UNIT III	THREE PHASE CIRCUITS	12

Phasor Diagram – Power, Power factor and Energy–Three phase balanced / unbalanced voltage sources – Analysis of three phase 3-wire and 4-wire circuits with star and delta connected, balanced & unbalanced loads – Power and power factor measurements in three phase circuits.

UNIT IV	TRANSIENT RESPONSE FOR DC, AC CIRCUITS	12

Transient response of RL, RC and RLC Circuits for DC input and AC sinusoidal input – Characterization of two-port networks in terms of Z, Y, h and transmission parameters.

UNIT V	RESONANCE AND COUPLED CIRCUITS	12

Series and parallel resonance – Frequency response – Quality factor and Bandwidth –Low and High pass filters –Self and mutual inductance – Coefficient of coupling – Singly tuned circuits.

TOTAL PERIODS: 60

TEXT BOOKS

1.	William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, 'Engineering Circuits Analysis', McGraw Hill Education, New Delhi, 2013, 8th Edition.
2.	Charles K. Alexander, Mathew N.O. Sadiku, 'Fundamentals of Electric Circuits', McGraw Hill Education, 2013, 5thEdiiton.
3.	Joseph A. Edminister, Mahmood Nahri, 'Electric circuits', Schaum's series, McGraw Hill Education, New Delhi, 2017, 5th Edition.

REFERENCE BOOKS

1.	Sudhakar A and Shyam Mohan SP, 'Circuits and Network Analysis and Synthesis', McGraw Hill Education, 2017, 5th Edition.
2.	Chakrabati A, 'Circuits Theory (Analysis and synthesis)', Dhanpath Rai and Sons, New Delhi, 1999.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Apply circuit laws to analyze steady-state parameters of given electrical circuits	4
2	Simplify DC and AC electrical circuits by applying suitable reduction methods and network theorems	3
3	Analyze three phase balanced and unbalanced circuits to determine power and power factor	4
4	Analyze transients of electrical circuits and parameters of two-port networks	4
5	Realize resonance phenomenon and the effect of magnetic coupling in real time applications	5

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	2	2				1			2	3	3
2	3	3	3	2	2				1			2	3	3
3	3	3	3	2	2				1			2	3	3
4	3	3	3	2	2				1			2	3	3
5	3	3	3	2	2				1			2	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

PH 22161	PHYSICS LABORATORY	L T P C
	(COMMON TO ALL BRANCHES EXCEPT BT)	0 0 2 1

COURSE OBJECTIVES

- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics and properties of matter.

LIST OF EXPERIMENTS (Any EIGHT Experiments)	
1.	a) Determination of Wavelength, and particle size using Laser. b) Determination of acceptance angle in an optical fiber.
2.	Determination of velocity of sound and compressibility of liquid – Ultrasonic Interferometer.
3.	Determination of wavelength of mercury spectrum – spectrometer grating.
4.	Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5.	Determination of Young's modulus by Non uniform bending method.
6.	Determination of specific resistance of a given coil of wire – Carey Foster's Bridge.
7.	Determination of Rigidity modulus of a given wire -Torsional Pendulum.
8.	Energy band gap of a Semiconductor.
9.	Determine the Hysteresis loss of a given Specimen.
10.	Calibration of Voltmeter & Ammeter using potentiometer.
	TOTAL PERIODS:30

REFERNCE BOOKS	
1.	"Physics Laboratory practical manual", 1st Revised Edition by Faculty members, 2018.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Analyze the physical principle involved in the various instruments; also relate the principle to new application	4
2	Comprehend the Experiments in the areas of optics, mechanics and thermal physics to nurture the concepts in all branches of Engineering	3
3	Apply the basic concepts of Physical Science to think innovatively and also improve the creative skills that are essential for engineering	3
4	Evaluate the process and outcomes of an experiment quantitatively and qualitatively	3
5	Extend the scope of an investigation whether or not results come out as expected	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	3	2				3	1		2		2
2	3	3		3		2			3	1		2		2
3	3	3	2	3	2	2			3	1		2		
4	3	3		3					3	1		2		
5	3	3		3	2				3	1		2	2	2
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														

CY22161	CHEMISTRY LABORATORY	L T P C
	(COMMON TO ALL BRANCHES EXCEPT AD, CS, IT)	0 0 2 1

COURSE OBJECTIVE

The objective of the Chemistry Laboratory is to acquaint the students with the basic phenomenon/concepts of chemistry, the student face during course of their study in the industry and Engineering field.

- To appreciate the need and importance of water quality parameters for industrial and domestic use.
- To gain the knowledge on electrochemical instrumentation techniques like potential and current measuring used in electrochemistry applications
- To impart knowledge on separation of components using paper chromatography.
- To enhance the thinking capability about polymer and properties like molecular weight.

LIST OF EXPERIMENTS (Minimum EIGHT Experiments)

1.	Determination of DO content of water sample by Winkler's method.
2.	Determination of strength of given hydrochloric acid using pH meter.
3.	Determination of strength of acids in a mixture using conductivity meter.
4.	Estimation of iron content of the water sample using spectrophotometer (phenanthroline / thiocyanate method).
5.	Determination of total, temporary & permanent hardness of water by EDTA Method.
6.	Estimation of iron content of the given solution using potentiometer.
7.	Determination of alkalinity in water sample.
8.	Determination of Single electrode potential.
9.	Separation of components from a mixture of red and blue inks using Paper chromatography.
10.	Determination of molecular weight of polymer by using Ostwald's/Ubbelohde viscometer

TOTAL PERIODS:30

REFERENCE BOOKS

1.	Daniel R. Palleros, 'Experimental organic chemistry' John Wiley & Sons, Inc., New York 2001.
2.	Furniss B.S. Hannaford A.J, Smith P.W.G and Tatchel A.R., 'Vogel‟s Textbook of practical organic chemistry', LBS Singapore 1994.
3.	Kolthoff I.M., Sandell E.B. et al. 'Quantitative chemical analysis', Mcmillan, Madras 1980
4.	Jeffery G.H., Bassett J., Mendham J.and Denny vogel‟s R.C, 'Text book of quantitative analysis chemical analysis', ELBS 5th Edn. Longman, Singapore publishers, Singapore, 1996.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Distinguish hard and soft water, solve the related numerical problems on water, purification and its significance in industry and daily life	3
2	Interpret the knowledge of instruments to measure potential and current related parameters	2
3	Demonstrate the basic principle for separation of components using paper chromatography	3
4	Evaluate the molecular weight of polymer using Ostwald's/Ubbelohde viscometer	3
5	Distinguish hard and soft water, solve the related numerical problems on water, purification and its significance in industry and daily life	3
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2				3	3	3	1		1	2		
2	3	2	1			3	3	3					**2**	**2**
3	3					3	3					2		
4	3			1		3	3	3						
5														

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22211	ELECTRIC CIRCUITS LABORATORY	L T P C
		0 0 3 1.5

COURSE OBJECTIVES

- To provide practical exposure in constructing and solving electrical circuits
- To simulate various electrical circuits using simulation software.

LIST OF EXPERIMENTS	
1.	Simulation and experimental verification of electric circuits by mesh and nodal analysis.
2.	Simulation and experimental verification of Thevenin's and Norton's theorems.
3.	Simulation and experimental verification of Maximum power transfer theorem.
4.	Simulation and experimental verification of Superposition and Millman's theorems.
5.	Simulation of three phase, balanced and unbalanced, star and delta networks.
6.	Simulation and experimental verification of DC transient analysis of electric circuits.
7.	Simulation of AC transient analysis (RL, RLC) of electric circuits.
8.	Determination of Z & Y two-port network parameters.
9.	Design, simulation and experimental verification of series resonant circuit.
10.	Design, simulation and experimental verification of parallel resonant circuit.
11.	Design, Simulation and experimental verification of low pass and high pass filters.
12.	Design and develop a PCB layout of given electrical circuit using software package. (Mini-Project

TOTAL PERIODS:45

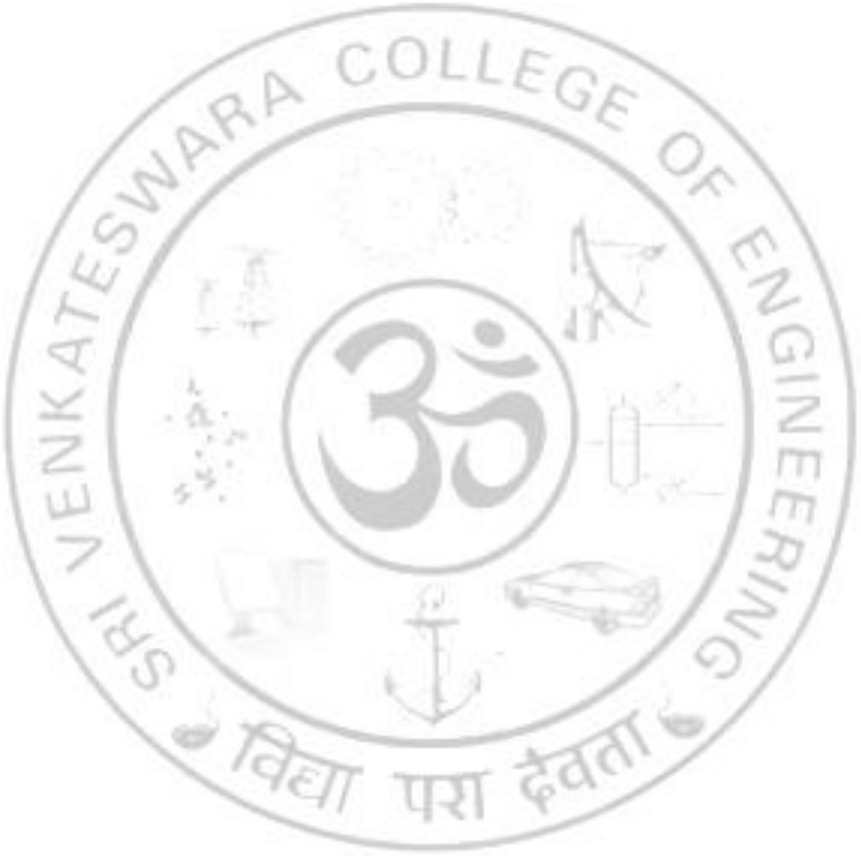
COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Apply circuit laws and theorems to analyze steady-state parameters of given electrical circuits	4
2	Simulate and compute power and power factor in balanced and unbalanced three-phase circuits	3
3	Analyze the transient parameters of the given DC and AC electrical circuits	4
4	Model and evaluate two-port network parameters	5
5	Design and estimate parameters of resonant and filter circuits and verify through experiments and simulation	5

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	2	3				3	2		2	3	3
2	3	3	2	2	3				3	2		2	3	3
3	3	3	2	2	3				3	2		2	3	3
4	3	3	2	2	3				3	2		2	3	3
5	3	3	2	2	3				3	2		2	3	3
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														



SEMESTER III

MA22354	MATHEMATICS FOR ELECTRICAL ENGINEERS	L T P C
		3 1 0 4

COURSE OBJECTIVES

- Introduce the Fourier series analysis.
- Introduce the basic concepts of the Fourier transform techniques and its application in engineering.
- Introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT I	PARTIAL DIFFERENTIAL EQUATIONS	9+3

Formation of partial differential equations – Singular integrals - Solutions of standard types of first order partial differential equations - Lagrange's linear equation – Linear homogeneous partial differential equations of second and higher order with constant coefficients.

UNIT II	FOURIER SERIES	9+3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series –Half range cosine series –Parseval's identity – Harmonic analysis

UNIT III	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	9+3

Classification of PDE – Method of separation of variables - Solution of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (excluding insulated edges).

UNIT IV	FOURIER TRANSFORMS	9+3

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity

UNIT V	Z - TRANSFORMS AND DIFFERENCE EQUATIONS	9+3

Z- transform - Elementary properties – Inverse Z - transform (using partial fraction, long division method and residue technique) –Convolution theorem - Formation of difference equations – Solution of difference equations using Z - transform.

TOTAL PERIODS (L:45+T:15): 60

TEXT BOOKS

1.	Erwin Kreyszig, 'Advanced Engineering Mathematics', Wiley India, 2011, 10th Edition.
2.	Grewal. B.S., 'Higher Engineering Mathematics', Khanna Publishers, Delhi 2017, 44th Edition.
3.	Narayanan.S., ManicavachagomPillay.T.K and Ramanaiah.G'Advanced Mathematics for Engineering Students' Vol. II & III, S.Viswanathan Publishers Pvt. Ltd. 1998.

REFERENCE BOOKS

1.	Bali.N.P and Manish Goyal, 'A Textbook of Engineering Mathematics', Laxmi Publications Pvt Ltd , 2007, 7th Edition.
2.	Glyn James, 'Advanced Modern Engineering Mathematics', Pearson Education, 2011, 4th Edition.
3.	Veerarajan. T., 'Transforms and Partial Differential Equations', Tata McGraw Hill Publishing Company Ltd., New Delhi, 2012.
4.	Ray Wylie. C and Barrett.L.C, 'Advanced Engineering Mathematics', Tata McGraw Hill

	Education Pvt Ltd, New Delhi, 2012.
5.	Peter V.O'Neil, 'Advanced Engineering Mathematics', Cengage Learning India Pvt. Ltd. 7th Edition, New Delhi, 2012.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Express proficiency in handling higher order Partial differential equations	4
2	Acquire the skill in examining a signal in another domain rather in the original domain by handling Full and Half Range Fourier Series	4
3	Develop skills in classification, formulation, solution, and interpretation of PDE models	4
4	Develop the skill of conversion between time domain to frequency domain using the concept of Fourier Transforms	5
5	Apply the systematic method for finding the impulse response of LTI systems described by difference equations: partial fraction expansion	5

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
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	3
5	3	3	3									3	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22301	ELECTRICAL MACHINES I	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Introduce techniques of Magnetic-circuit analysis and introduce Magnetic materials.
- Impart the principle of Operation, Construction, Testing of Single Phase Transformers and Three Phase Transformer Connections.
- Illustrate the theory of Electromechanical energy conversion and the concept of Co-energy.
- Familiarize the working principle of different types of DC machines and analyze the losses in DC machines to improve the efficiency by conducting various tests.
- Study the characteristics and speed control methods of DC machines.

UNIT I	MAGNETIC CIRCUITS AND MAGNETIC MATERIALS	9

Magnetic circuits – Laws governing magnetic circuits –Flux linkage, Inductance and energy – Statically & Dynamically induced EMF – Torque – Properties of magnetic materials, Hysteresis and Eddy Current losses – AC excitation, Introduction to permanent magnets.

UNIT II	TRANSFORMERS	9

Construction –Principle of operation on no load and load – Equivalent circuit – Phasor diagram – Losses – Testing – Efficiency and Voltage regulation – All day efficiency – Sumpner test, Per unit representation – Three phase transformers – Connections and their comparative features, Scott Connection – Parallel operation of transformers – Auto transformer – tap changing transformers.

UNIT III	ELECTROMECHANICAL ENERGY CONVERSION AND CONCEPTS IN ROTATING MACHINES	9

Energy in magnetic system – Field energy and co-energy – Force and torque equations – Singly and multiply excited magnetic field systems – Generated EMF – MMF of distributed windings – Magnetic fields in rotating machines – Rotating MMF waves – Magnetic saturation and leakage fluxes – Torque in round rotor machine.

UNIT IV	DC GENERATORS	9

Construction & Components of DC Machines – Cooling, Mounting, Standards & Specifications, Principle of operation – Lap and wave windings – EMF equations– Circuit model – Armature reaction – Methods of excitation – Commutation – Compensating winding – Losses, Efficiency and Power stages in DC Generator – Characteristics of DC generators – Parallel operation of shunt generator – Applications.

UNIT V	DC MOTORS	9

Principle of operation – Types of DC Motors – Back EMF and Torque equations – Speed Torque Characteristics – Starting – Types of Starters – Speed control – Testing and efficiency – Swinburne's test and Hopkinson's test –Testing standards– IEC, NEMA – Applications.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Nagrath I. J and Kothari D. P. 'Electric Machines', Tata McGraw Hill Publishing Company Ltd, 2017, 5th Edition.
2.	P.S. Bimbhra, 'Electrical Machinery', Khanna Publishers, 2021.

REFERENCE BOOKS

1.	M.N.Bandyopadhyay, 'Electrical Machines Theory and Practice', PHI Learning Pvt Ltd., New Delhi, 2009.
2.	P. C. Sen, 'Principles of Electrical Machines and Power Electronics', John Wiley and Sons,

	1997.
3.	Deshpande M. V, 'Electrical Machines', PHI Learning Pvt. Ltd., New Delhi, 2011.
4.	Fitzgerald. A.E., Charles Kingsely Jr, Stephen D.Umans, 'Electric Machinery', Tata McGraw Hill Books Company, 2003, 6th Edition.
5.	S.SarmaandK.Pathak, 'Electric Machines', Cengage Learning India (P) Ltd., Delhi, 2011.
6.	Richard C Dorf, 'Electrical Power Engineering hand book', CRC Press, 1998.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Analyze magnetic circuits and determine the performance parameters	4
2	Compute the performance parameters of single phase and three phase transformers	3
3	Derive torque of rotating machines and analyze the machine performance	3
4	Estimate the electro-mechanical performance of DC Generators	4
5	Apply different methods of starting & speed control and determine the performance of DC Motors	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	2	3			2					3	3	3
2	3	2	2	3								3	3	3
3	3	2	2	3			2					3	3	3
4	3	2	2	3			2					3	3	3
5	3	2	2	3		3	2					3	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22302	ELECTRIC POWER SYSTEM	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Learn about various components of Power systems.
- Calculate the transmission line parameters for various conductor configurations.
- Predict the performance of Transmission lines.
- Understand about different Insulators and Underground cables.
- Familiarize the basic concepts related to Substation and Distribution system.

UNIT I	STRUCTURE OF POWER SYSTEM	9

Structure of Electric Power System– Conventional, Deregulated Structure, Micro-grid and Smart Grid Structure – Methods of electric power generations – Conventional (Thermal and Hydro Power Plants) – Renewable Energy based generation – Trends in Transmission and Distribution: EHVAC, HVDC and FACTS – Indian Electricity (IE) Rules and Acts – Tariff – Types – Electrical Safety.

UNIT II	TRANSMISSION SYSTEM PARAMETERS	9

Resistance, Inductance and Capacitance calculations -solid, stranded, and bundled conductors- Single-phase and three phase lines – single and double circuit lines - Typical configuration, conductor types - Symmetrical and unsymmetrical spacing and transposition – application of self and mutual GMD - skin and proximity effects– effect of earth on transmission line capacitance-Distribution line model

UNIT III	MODELLING AND PERFORMANCE OF TRANSMISSION LINES	9

Classification of lines- Performance of Transmission lines – short line, medium line and long line – ABCD constants - equivalent circuits, phasor diagram – real and reactive power flow in lines – Power Circle diagrams – Ferranti effect- shunt and series compensation- surge-impedance loading, loadability limits based on thermal loading – Formation of Corona – Critical Voltages – Effect on line Performance.

UNIT IV	INSULATORS, CABLES AND SAG CALCULATION	9

Insulators: Types – voltage distribution in insulator string – improvement of string efficiency – testing of insulators, Underground cables: Underground cables – Types of cables – insulation resistance –potential gradient – capacitance of single-core and three-core cables- Grading of cables – DC cables, Mechanical designs of transmission line: sag and tension calculations for different weather conditions – Tower spotting & Types of towers.

UNIT V	SUBSTATION, GROUNDING SYSTEM AND DISTRIBUTION SYSTEM	9

Classification, major components of substations - Bus-bar arrangements - Importance of earthing in a substation - Qualitative treatment to neutral grounding and earthing practices in substations - Distribution Systems – Kelvin's Law – AC and DC distributions –Concentrated and Distributed loading- Techniques of Voltage Control and Power factor improvement – Distribution Loss- Anti-theft measures – Demand side management (Qualitative)

TOTAL PERIODS: 45

TEXT BOOKS

1.	Gupta B.R, 'Power System Analysis & Design', S.Chand and Company Ltd, 2014, 7th Edition.
2.	Metha.V.K, and Rohit Metha., 'Principles of Power System', S.Chand and Company Ltd., 2020.

REFERENCE BOOKS

1.	Hadi Saadat, 'Power System Analysis,' PSA Publishing; 2011, 3rdEdiiton.

2.	Wadwa. C.L., 'Electric Power Systems, New Age International (P) Ltd', New Delhi, 2022, 8th Edition.
3.	John J. Grainger and Stevenson Jr. W. D, 'Power System Analysis', McGraw Hill International edition, 2016.
4.	S.N. Singh, 'Electric Power Generation, Transmission and Distribution', Prentice Hall of India Pvt. Ltd, New Delhi, Second Edition, 2011.
5.	D.P.Kothari and I.J. Nagrath, 'Power System Engineering', Tata McGraw–Hill, 2019, 3rd Edition.
6.	Central Electricity Authority (CEA), "Guidelines for Transmission System Planning", New Delhi.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Understand the major components of power system and its practical significance	4
2	Determine transmission line parameters for various conductor configurations	5
3	Model the transmission lines to determine the line performance and analyze the impact of Ferranti and coronaeffects	4
4	Calculate electrical parameters of overhead and underground cables and perform sag calculations	4
5	Analyze substation, grounding and distribution systems	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	2		2						3	3	
2	3	3	2	2								3	3	2
3	3	3	2	2								3	3	2
4	3	3	2	2								3	3	2
5	3	3	2	2								3	3	

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22303	ELECTROMAGNETIC THEORY	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Introduce the basic mathematical concepts related to Electromagnetic vector fields.
- Impart the concepts of Electrostatics, Electrical potential and boundary conditions.
- Inculcate the concepts of Magnetostatics, Magnetic flux density, scalar and vector potential and its applications.
- Investigate the equations of Electrodynamic field and EM wave.

UNIT I	BASICS OF ELECTROMAGNETIC VECTOR FILEDS	9

Sources and effects of Electromagnetic fields – Vector algebra - Scalars, Vectors, Dot product, Cross product - Coordinate Systems – Cartesian, Cylindrical and Spherical Coordinate system – Coordinate transformations – Line, Surface and Volume integrals – Gradient, Divergence, Curl – Theorems and Applications.

UNIT II	ELECTROSTATICS – I	9

Coulomb's Law – Electric field intensity – Field due to discrete and continuous charges – Gauss's law and Applications. Electric potential due to discrete and continuous charges – Electric field and equipotential plots, Electric dipole - Uniform and Non-Uniform field, Utilization factor.

UNIT III	ELECTROSTATICS – II	9

Electric field in free space, conductors, dielectrics – Dielectric polarization – Dielectric strength – Electric field in multiple dielectrics – Boundary conditions - Poisson's and Laplace's equations, Uniqueness Theorem, General procedure for solving Poisson's and Laplace's equations–Capacitors and Capacitance of Parallel, Coaxial, Spherical conductors– Energy density–Case study on real time applications.

UNIT IV	MAGNETOSTATICS	9

Lorentz force, magnetic field intensity (H) – Biot–Savart's Law – Ampere's Circuit Law – H due to straight conductors, circular loop, infinite sheet of current, Magnetic flux density (B) – Magnetic materials– Magnetization, Magnetic field in multiple media Magnetic force, Torque, Self and mutual inductance – Inductance of a solenoid, Energy density, Applications.

UNIT V	ELECTRODYNAMIC FIELDS AND WAVES	9

Magnetic Circuits – Faraday's Law– Transformer and motional EMF – Displacement current – Maxwell's equations (differential and integral form) – Applications – Time harmonic fields – Electromagnetic waves – Properties of EM waves in Lossy medium.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Mathew N. O. Sadiku, S.V.Kulkarni 'Principles of Electromagnetics', Oxford University Press Inc,Asian edition,2015, 6th Edition.
2.	K.A. Gangadhar, P.M. Ramanthan 'Electromagnetic Field Theory (Including Antennae's and wave propagation', Khanna Publications, 2013, 16th Edition.

REFERENCE BOOKS

1.	William H. Hayt and John A. Buck, 'Engineering Electromagnetics', Tata McGraw Hill Special Indian edition, 2014.
2.	Karl E Lonngren,Sava V Savov, Randy J Jost, ' Fundamentals of Electromagnetic with MATLAB', Prentice Hall of India, 2012.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Apply basic mathematical concepts to solve electromagnetic vectors in orthogonal coordinate system	4
2	Interpret and solve the problems related to electrostatics	4
3	Apply the electrostatic principles to compute the boundary value problems and analyze Electric field in material space	4
4	Analyze and solve the problems related to magneto-statics	4
5	Solve time-varying fields using Maxwell's equation and Electromagnetic wave equation	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	2					2			3	2	3
2	3	3	3	2					2			3	2	3
3	3	3	3	2					2			3	2	3
4	3	3	3	2					2			3	2	3
5	3	3	3	2					2			3	2	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22308	DIGITAL LOGIC CIRCUITS: THEORY AND PRACTICES	L T P C
		3 0 2 4

COURSE OBJECTIVES

- To impart knowledge on concepts of binary representation, logic gates, and Boolean algebra.
- To design and analyze digital circuits using combinational and sequential logic.
- To develop skills in HDL coding and simulate digital circuits.

UNIT I	NUMBER SYSTEMS, CODES AND BOOLEAN REDUCTION	9+6

Review of number systems, Signed binary numbers – Binary Arithmetic – Fixed and floating point representation – Boolean Algebra - laws and theorems – Simplification of Boolean expressions – Sum of Products (SOP) and Product of Sums (POS) forms – Logic Minimization using K-map – Binary codes – BCD code, Gray code, Error detection and Error correction codes.

Experiments:

1. Reduction and Implementation of Boolean Expression using logic gates (K-map).
2. Implementation of Code Converters (Binary to Gray, and Gray to Binary) using logic gates.

UNIT II	COMBINATIONAL CIRCUITS	9+6

Combinational logic – Adders, Ripple carry adder, Carry lookahead adder, Subtractor, Multiplexer, Demultiplexer, Encoder, Decoder, Parity generator and checker – Introduction to VHDL coding.

Experiments:

1. Implementation of Adder and Multiplexer.
2. Design and simulation of Adder/ Subtractor circuits.
3. Design and simulation of Multiplexer and Demultiplexer.

UNIT III	SEQUENTIAL CIRCUITS	9+6

Sequential logic – SR, JK, D and T flip flops –Synchronous counter – Ripple Counter – Modulo-n counter –Sequence generator – Design of synchronous sequential circuits – Moore and Mealy models – state diagram, state reduction, state assignment.

Experiments:

1. Implementation and simulation of Shift registers.
2. Design, implementation and simulation of Synchronous counter.

UNIT IV	ASYNCHRONOUS SEQUENTIAL CIRCUITS	9+6

Design of Asynchronous sequential circuits – Transition table, flow table – race conditions, hazards and errors in digital circuits; Analysis of asynchronous sequential logic circuits – Design of asynchronous controller for vending machine.

Experiments:

1. Design, implementation and simulation of Asynchronous counter.

UNIT V	MEMORY DEVICES AND DIGITAL LOGICAL FAMILIES	9+6

Implementation of combinational logic circuits using PROM, PLA, PAL – Introduction to FPGA – Digital Logic Families: Logic gates using TTL, ECL and MOS families – operation and characteristics of digital logical family.

Experiments:

1. Implementation and verification of two input NOR and NAND gates using TTL/CMOS

TOTAL PERIODS: 45+30

TEXT BOOKS	
1.	M. Morris Mano, 'Digital Design with an introduction to the VHDL', Pearson Education, 2013.
2.	John M.Yarbrough, 'Digital Logic, Application & Design', Thomson, 2012.
REFERENCE BOOKS	
1.	Salivahanan, Arivazhagan, 'Digital Circuits & Design', Vikas Publishing House, 2012.
2.	William Kleitz, 'Digital Electronics-A Practical Approach with VHDL', Pearson, 2014.
3.	Floyd and Jain, 'Digital Fundamentals', 8th edition, Pearson Education, 2013.
4.	Anand Kumar, 'Fundamentals of Digital Circuits', PHI,2013.
5.	Gaganpreet Kaur, 'VHDL Basics to Programming', Pearson, 2013.
6.	Mandal, 'Digital Electronics Principles & Application', McGraw Hill Education, 2014.

COURSE OUTCOMES

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

CO's	STATEMENTS	RBT LEVEL
1	Apply the concepts of Boolean algebra and reduction techniques to minimize logic expressions	3
2	Analyze and design various combinational logic circuits	4
3	Investigate and design synchronous and asynchronous sequential circuits	4
4	Comprehend the operation, characteristics of memory devices, digital logic families and construct digital circuits with memory devices	3
5	Design, debug and verify simple digital circuits and systems with the aid of HDL codes, schematic capture tools and simulation tools	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3							3	3			3	
2	3	3	2	2	3				3	3		2	3	2
3	3	3	2	2	3	2			3	3		3	3	2
4	3	3	2	2	3	2			3	3		3	3	
5	3	3	2	2	3	2			3	3		3	3	

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

LABORATORY REQUIREMENTS FOR A BATCH OF 30 STUDENTS		
SL.NO	**DESCRIPTION OF EQUIPMENTS**	**QUANTITY REQUIRED**
1.	IC Trainer kit	10
2.	IC Tester	4
3.	Bread board	10
4.	ICs - Logic gates, Flip-flops	Each 10
5.	Connecting wires	As required

EE22309	ELECTRON DEVICES AND CIRCUITS: THEORY AND PRACTICES	L T P C
		3 0 2 4

COURSE OBJECTIVES

- To understand the structure, operation, characteristics and applications of basic electronic devices.
- To gain knowledge about biasing circuits.
- To learn the required functionality of positive and negative feedback systems.
- To study about Optoelectronic devices.
- To construct various electronic circuits and understand the theoretical concepts by practices.

UNIT I	PN JUNCTION DEVICES AND APPLICATIONS	9+6

Construction and operation of PN junction diode, Current equations, Transition capacitance and Diffusion capacitance, Reverse recovery time, Temperature Effects-Construction and operation of Zener diode, Varactor diode.

Experiments:

1. V-I characteristics of PN Junction diodes and Zener diode
2. Clippers and Clampers using Diodes
3. Simulation study of Rectifiers with and without filters
4. Zener diode as voltage regulators

UNIT II	BIPOLAR JUNCTION TRANSISTORS	9+6

Construction and operation of Transistor, Modes of operation, Different types of configurations, Thermal runaway and Stabilization, AC and DC load lines, Need for biasing a Transistor and various biasing techniques-BJT small signal model–Analysis of CE, CB, CC amplifiers–Determination of h parameters.

Experiments:

1. Input and Output characteristics of Common Emitter.
2. Frequency analysis of Common Emitter.

UNIT III	FIELD EFFECT TRANSISTORS	9+6

Construction and Principle of operation of JFET and MOSFET, Biasing circuits for MOSFET-Fixed bias, Self bias, Voltage divider bias-Small signal model of FET/MOSFET - Analysis of CS, CG and Source Follower-Construction and Principle of operation of UJT.

Experiments:

1. Characteristics of MOSFET, UJT.

UNIT IV	MULTISTAGE AND FEEDBACK AMPLIFIERS	9+6

Two stage RC coupled amplifier –Analysis of Differential amplifier, Single tuned amplifiers–Gain and Frequency response – Neutralization methods, power amplifiers –Types (Qualitative analysis). Advantages of negative feedback – Analysis of Voltage/ Current, Series, Shunt feedback Amplifiers using Transistor.

Experiments:

1. Transfer Characteristics of Differential amplifier

UNIT V	OSCILLATORS AND OPTOELECTRONIC DEVICES	9+6

Positive feedback, Condition for oscillations, Phase shift – Wien bridge-Hartley-Colpitts and Crystal Oscillators- Construction and Operation of Optoelectronic devices: LED, LCD, Photo Diode, Photo Transistor, Opto-Coupler and Solar Cell.

Experiments:

1. Design and testing of RC phase shift and LC oscillators.
2. Characteristics of LED.

3. Experimental study of Opto-isolator (IC 4N28).	
TOTAL PERIODS: 45+30	
TEXT BOOKS	
1.	Boylestead L R and Nashelsky L, 'Electronic Devices and Circuit theory', Pearson Prentice Hall, New Delhi, 2018, 11th edition.
2.	Salivahanan, Suresh kumar, 'Electronic Devices and Circuits', Tata McGraw Hill 2013, 3rd edition.
REFERENCE BOOKS	
1.	Thomas L Floyd, 'Electronic Devices', Prentice Hall of India, New Delhi, 2013, 7th edition.
2.	Donald A Neamen, 'Electronic Circuit Analysis and Design', Tata McGraw Hill 2007, 3rd edition.
3.	G.K.Mithal, 'Electronic devices and circuits', Khanna Publishers, New Delhi, 2010, 23rd edition.
4.	Millman J, Christos C Halkias, SatyabatraJit, 'Electronic devices and circuits', Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2012, 3rd edition.
5.	Theodore F Bogart Jr, Jefffrey S Beasley, Guillermo Rico' 'Electronic devices and circuits', Prentice Hall of India, New Delhi, 2004, 6th edition.
6.	For datasheets: https://www.alldatasheet.com/

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Apply the concepts of PN junction devices and analyse its various electronic circuits	4
2	Analyse the various configurations of bipolar junction transistors and amplifiers	4
3	Analyse the various configurations of field effect transistors and amplifiers	4
4	Analyse the performance of multistage and feedback amplifier circuits	4
5	Understand the operation of oscillators and Optoelectronic devices and analyse its behaviour using practices	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	2	3				3	3		2	3	
2	3	3	3	2	3				3	3		2	3	
3	3	3	3	2	3				3	3		2	3	
4	3	3	3	2	3				3	3		2	3	
5	3	3	3	2	3				3	3		2	3	
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														

LABORATORY REQUIREMENTS FOR A BATCH OF 30 STUDENTS		
SL.NO	**DESCRIPTION OF EQUIPMENTS**	**QUANTITY REQUIRED**
1.	Regulated Power supply	15
2.	CRO 30MHz	6
3.	DSO	2
4.	Function Generator	6
5.	Digital Multimeter	6
6.	Bread board	10
7.	Diode, Zener diode, BJT, UJT, JFET, MOSFET, UJT, LED, Photodiode, Phototransistor and Opto-coupler IC	Each 10
8.	Ammeter in various milli and micro ampere ranges	15
9.	Voltmeter in various ranges between 0-30V	15
10.	Resistors of various ranges	50
11.	Capacitors of various ranges	25
12.	Connecting wires	As required

EE22311	ELECTRICAL MACHINES I LABORATORY	L T P C
		0 0 3 1.5

COURSE OBJECTIVES

- Evaluate the Load characteristics of DC machines and transformers.
- Examine the performance characteristics of DC machines and Transformers using Direct and Indirect tests.
- Investigate different Speed control methods of DC Shunt Motor.
- Understand the need for starters.
- Obtain the Load test plots for Three Phase Transformers.

LIST OF EXPERIMENTS

	DC Machines
1.	Open circuit and Load characteristics of DC Separately Excited and Self Excited Shunt Generator
2.	Load characteristics of DC Compound Generator with differential and cumulative connections
3.	Load test on DC Shunt, Series and Compound motor
4.	Swinburne's test
5.	Hopkinson's test on DC Motor – Generator set
6.	Study of Starters, Regenerative and Dynamic braking for DC motors
7.	Speed control of DC shunt Motor and its 4 Quadrant operation
	Transformers
8.	Load test on Single-Phase Transformer and Three Phase Transformers
9.	Open circuit and Short circuit tests on Single Phase Transformer
10.	Polarity Test and Sumpner's test on Single Phase Transformers
11.	Separation of no-load losses in Single Phase Transformer

TOTAL PERIODS:45

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Determine the performance characteristics of a DC machine operating as a Generator or Motor	3
2	Estimate the performance of a DC machine by Indirect methods	4
3	Identify and apply suitable method of starting, speed control and braking of a DC motor	3
4	Determine the performance characteristics of Single and Three Phase Transformers	4
5	Pre-determine the performance of Single phase Transformer	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	2	2	2		2	3	2		2	3	
2	3	3	3	2		2		2	3	2		2	3	
3	3	3	3	2	2	2		2	3	2		2	3	
4	3	3	3	2	2	2		2	3	2		2	3	2
5	3	3	3	2		2		2	3	2		2	3	2
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														

LABORATORY REQUIREMENTS FOR A BATCH OF 30 STUDENTS		
SL.NO	**DESCRIPTION OF EQUIPMENTS**	**QUANTITY REQUIRED**
1.	DC Separately excited generator coupled with DC Shunt Motor	1
2.	DC Shunt generator Coupled with DC Shunt Motor	1
3.	DC Shunt Motor Coupled with DC Compound Generator	1
4.	DC Shunt Motor with loading Arrangement	1
5.	DC Series Motor with loading Arrangement	1
6.	DC Compound motor with loading Arrangement	1
7.	DC drive for 4 quadrant operation of dc motor	1
8.	Dynamic braking panel for dc motor	1
9.	Single Phase Transformer	6
10.	Three phase Transformer	2
11.	Single Phase Resistive Loading Bank	2
12.	Three Phase Resistive Loading Bank	2
13.	Tachometer -Digital/Analog	8
14.	Single Phase Auto Transformer	5
15.	Three Phase Auto Transformer	1
16.	SPST switch	3
17.	Wattmeter	10
18.	Lamp loading arrangement	3
19.	Ammeters	20
20.	Voltmeters	20
21.	Rheostats	15

SEMESTER-IV

MA22452	NUMERICAL METHODS	L T P C
	(COMMON TO CH ANDEE)	3 1 0 4

COURSE OBJECTIVES

- Learn the solution of algebraic, transcendental equations, system of linear equations
- Understand the concept of Interpolation and approximation.
- Learn how to apply numerical differentiation and Integration
- Familiarize in solving IVP
- Understand how to solve BVP in ODE and PDE

UNIT I	SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS	12

Introduction to computation software for numerical methods solution of algebraic and transcendental equations – Newton Raphson method- Solution of linear system of equations – Gauss elimination method – Pivoting - Gauss Jordan method, Solution of Tri-diagonal system of equations – Gauss Seidel iterative method – Matrix Inversion by Gauss Jordan method – Eigen values of a matrix by Power method and Jacobi Method for symmetric matrix. Solving equations and Eigen value problems using computational tools.

UNIT II	INTERPOLATION AND APPROXIMATION	12

Finite difference operators and its relations – Interpolation with equal intervals – Newton's forward and backward difference formulae – Interpolation with unequal intervals – Lagrange's interpolation – Newton's divided difference interpolation–Interpolation and Approximation using computational tools.

UNIT III	NUMERICAL DIFFERENTIATION AND INTEGRATION	12

Approximation of derivatives using interpolation polynomials – Numerical integration using Trapezoidal, Simpson's 1/3 rule, Romberg's Method – Two point and three-point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules–Application of computational tools for numerical differentiation and integration.

UNIT IV	INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS	12

Single Step methods – Taylor's series method, Modified Euler's method – Fourth order Runge-Kutta method for solving first order equations, second order equations and simultaneous first order equations – Multi step methods – Milne's and Adams- Bash forth predictor corrector methods for solving first order equations– Solving Initial value problems using computational tools.

UNIT V	BOUNDARY VALUE PROBLEMS	12

Finite difference solution of ODE. Finite difference techniques for the solution of two-dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method–Solving Boundary value problems using computational tools.

TOTAL PERIODS:60

TEXT BOOKS

1.	Grewal. B.S., 'Numerical Methods in Engineering and Science with Programs in C, C++ &MATLAB', Khanna Publishers, New Delhi, 2013, 11th Edition.
2.	Jain M.K., Iyengar. S.R.K., and Jain. R.K, 'Numerical Methods for Scientific and Engineering Computation', New Age International Publishers, New Delhi, 2015.
3.	Chapra. S.C., and Canale.R.P., 'Numerical Methods for Engineers', Tata McGraw Hill, New Delhi, 2015, 7th Editon.

REFERENCE BOOKS	
1.	Sankara Rao. K., Numerical methods for Scientists and Engineers, Prentice Hall of India, New Delhi, 2007, 3rd Edition.
2.	Gerald. C. F., and Wheatley. P. O., 'Applied Numerical Analysis', Pearson Education, Asia, New Delhi, 2009.
3.	Venkataraman. M.K. 'Numerical Methods in Science and Engineering', National Publishers, 2001.
4.	Kandasamy. K., Thilagavathy. K., and Gunavathi. K., 'Numerical Methods', S. Chand &Company Ltd., New Delhi, 2008.
5.	Sastry, S.S., 'Introductory Methods of Numerical Analysis', Prentice Hall of India, 2010.
	WEBLINKS
1.	https://nptel.ac.in/courses/111/107/111107105/
2.	https://nptel.ac.in/courses/111/107/111107063/

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Have the fundamental knowledge of solving an algebraic or transcendental equation, linear system of equations	3
2	Appreciate the numerical techniques of interpolation in various intervals	4
3	Apply the numerical techniques of differentiation and integration for engineering problems	3
4	Solve Initial value problems using an appropriate numerical technique	5
5	Solve Boundary value problems using finite difference method	5

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2									2	3	3
2	3	3	2									2	3	3
3	3	3	2										3	3
4	3	3	2	2									3	3
5	3	3	2	2									3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

GE22451	ENVIRONMENTAL SCIENCES AND SUSTAINABILITY	L T P C
	(COMMON TO ALL BRANCHES)	3 0 0 3

COURSE OBJECTIVES

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution.
- To study and understand the various types of renewable sources of energy and their applications.
- To familiarize the concept of sustainable development goals, economic and social aspects of sustainability, recognize and analyze climate changes, and environmental management challenges.
- To inculcate and embrace sustainability practices, develop a broader understanding of green materials and energy cycles, and analyze the role of sustainable urbanization.

UNIT I	ENVIRONMENT AND BIODIVERSITY	9

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– food chains, food webs and ecological pyramids, ecological succession. Biodiversity– types–genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: fragmentation and habitat loss, poaching of wildlife, human-wildlife conflicts – endangered and endemic species of India –conservation of biodiversity: In-situ and ex-situ.

UNIT II	ENVIRONMENTAL POLLUTION	9

Definition, causes, effects and preventive measures of air, water and soil pollution. Marine and thermal pollution – causes, effects and control measures. Light and noise pollution–effect on flora and fauna. Nuclear pollution– Sources, effects and control measures. Disposal of radioactive wastes (Nuclear hazards). Pollution case studies. Role of an individual in the prevention of pollution. Solid, hazardous and E-waste management. Occupational health and safety management system (OHASMS). Environmental protection, Environmental protection acts, categorization of spices according to IUCN.

UNIT III	RENEWABLE SOURCES OF ENERGY	9

Energy resources: Growing energy needs, Non renewable resources – types, uses. Energy management and conservation – New energy sources, Need of new sources – geo suitability of establishing renewable energy sources, different types new energy sources. Applications of hydrogen energy, ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy. Role of an individual in conservation of energy.

UNIT IV	SUSTAINABILITY AND MANAGEMENT	9

Development, GDP, Sustainability– concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols, Sustainable Development Goals-targets, indicators and intervention areas –Principles of green chemistry, Climate change- Global, Regional and local environmental issues and possible solutions-case studies – Role of non-governmental organization, Concept of carbon credit, carbon footprint – Environmental management in industry–A case study.

UNIT V	SUSTAINABILITY PRACTICES	9

Zero waste and R concept, circular economy, ISO 18000 series, material life cycle assessment, environmental impact assessment. Wasteland reclamation, Sustainable habitat: green buildings, green materials, energy efficiency and energy audit, sustainable transports. Energy cycles, carbon cycle, emission and sequestration, Green engineering: sustainable urbanization- socio-economical and technological change.

Rain water harvesting, watershed management environmental ethics: Issues and possible solutions.	
TOTAL PERIODS: 45	
TEXT BOOKS	
1.	Anubha Kaushik and C. P. Kaushik's 'Perspectives in Environmental Studies', NewAge International Publishers, 7th Edition, 2022.
2.	Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3.	Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', Pearson Education2nd edition, 2004.
4.	Allen, D. T. and Shonnard, D. R., 'Sustainability Engineering: Concepts, Design and Case Studies', Prentice Hall.
5.	Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design anddevelopment, Cengage learning.
6.	'Environment Impact Assessment Guidelines, Notification of Government of India', 2006.
7.	Mackenthun, K.M., 'Basic Concepts in Environmental Management', Lewis Publication, London, 1998.
REFERENCE BOOKS	
1.	R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media.
2.	Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3.	Dharmendra S. Sengar, 'Environmental law', Prentice Hall of India PVT. LTD, New Delhi, 2007.
4.	Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 3rdedition, 2015.
5.	Erach Bharucha "Text book of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd, 2021, Edition.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Recognize the fundamental role of ecosystems and suggest an appropriate method for the conservation of biodiversity	3
2	Describe the different types of pollution, their effects and strategies to control pollution	3
3	Identify the various renewable energy resources and use the appropriate one thereby conserving non-renewable resources for future generation	3
4	Explain the various goals of sustainable development applicable to suitable technological advancement and societal development	2
5	Summarize the various sustainability practices, green materials, energy cycles, and the role of green engineering in sustainable urbanization	2

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3					3	3	2		2		1	2	2
2	3					3	3	2		2		2	2	2
3	3		1			3	3	1		2		1	2	2
4	3					3	3	3		2		2	2	2
5	3					3	3	3		2		2	2	2
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														

EE22401	ANALOG ELECTRONICS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand the Monolithic IC Fabrication process.
- To perform mathematical operations using Op-amp.
- To learn about various applications of Op-amp.
- To understand the functioning of ICs-Voltage regulators and amplifiers

UNIT I	IC FABRICATION	9

Monolithic IC technology–Basic planar processes–Fabrication of Monolithic transistors, FET, Monolithic diodes, Integrated resistors, Integrated capacitors, and PV cell, Thin and Thick film technology.

UNIT II	LINEAR IC – OPERATIONAL AMPLIFIER	9

Basic of Op-Amp, Internal Block Diagram and Ideal characteristics, DC characteristics, AC characteristics – Basic Applications: Inverting Amplifier, Inverter, Scale changer, Inverting summer – Non Inverting Amplifier, Voltage follower, Non Inverting summer, Differential Amplifier, Subtractor, Instrumentation amplifier, Differentiator, Integrator.

UNIT III	APPLICATIONS OF OPERATIONAL AMPLIFIER	9

Instrumentation amplifier V to I, I to V Converters, Comparator, Clipper, Clamper, Peak Detector, Multivibrators, Waveform Generation: Triangular, Saw tooth, Sinusoidal, Schmitt Trigger – I order and II order active filters – A/D converters (Dual Slope, Successive Approximation and Flash), D/A converters (R-2R ladder and weighted resistor) – Precision Rectifiers –Sample and Hold circuit.

UNIT IV	SPECIAL ICs	9

555 Timer-Functional Block Diagram, Characteristics, Monostable and Astable modes of operation– 565 Phase Locked Loops (PLL) - Block Diagram, operation – 566 Voltage controlled Oscillator, PLL, Applications –Analog multiplier and Divider, AD633-Analog multiplier ICs.

UNIT V	APPLICATION ICs	9

IC voltage regulators, LM78XX, 79XX– Fixed and adjustable three terminal regulators, LM723 General purpose voltage regulator, Block diagram, Circuit configurations, Current limiting schemes, Output current boosting, Switching regulators–SMPS–LM324 Single Supply Quad Operational amplifiers—LM380 Power amplifier–AD623 Instrumentation amplifier and its application.

TOTAL PERIODS: 45

TEXT BOOKS

1.	D.RoyChoudhary, ShailB.Jain, 'Linear Integrated Circuits', New Age, 2017, 4th Edition.
2.	Ramakant A.Gayakward,'Operational amplifiers and Linear Integrated Circuits', Pearson Education, PHI. 2015, 4th Edition.

REFERENCE BOOKS

1.	David A.Bell, 'Operational amplifiers and Linear ICs', Oxford, 2013, 3rd Edition.
2.	Robert F.Coughlin, Fredrick F. Driscoll, 'Operational amplifier and linear integrated circuits", Prentice Hall of India 2014, 6th Edition.
3.	Sergio Franco, 'Design with Operational Amplifiers and Analog Integrated Circuits', McGraw Hill, 2017, 4th Edition.

COURSE OUTCOMES		
Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Comprehend the fundamental techniques for fabrications of Monolithic elements and devices.	4
2	Demonstrate the basic applications of Op-amp.	4
3	Construct waveform generation circuits of Op-amp and converters.	4
4	Examine the internal schematic layout and operation of Special ICs.	4
5	Practice with different applications based on Application IC's.	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	2	2			2	2	2		2	2	
2	3	3	3	2	2			2	2	2		2	2	2
3	3	3	3	2	2			2	2	2		2	2	2
4	3	3	3	2	2			2	2	2		2	2	2
5	3	3	3	2	2			2	2	2		2	2	2

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22402	CONTROL SYSTEMS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Understand the use of transfer function models for analysis of physical systems and introduce the control system components.
- Impart adequate knowledge on the time response of various systems and steady state error analysis.
- Accord basic knowledge in obtaining the open loop and closed loop frequency responses of systems and stability analysis.
- State the need of controller in closed loop system and design the compensators.
- Learn state variable representation of physical systems and study the effect of state feedback.

UNIT I	SYSTEMS AND THEIR REPRESENTATION	9

Basic elements in control systems – Open and closed loop systems – Transfer function –Modelling of mechanical and electrical systems – Analogy – Synchros – AC and DC servomotors – overall system gain – Block diagram reduction techniques – Signal flow graphs – Thermal and pneumatic system.

UNIT II	TIME RESPONSE	9

Type and order of the system – Types of test input – Time response of first and second order system – Time domain specifications static and dynamic Error coefficients – Steady state error – Root locus technique.

UNIT III	FREQUENCY RESPONSE	9

Frequency response – Frequency domain specifications – Correlation between frequency domain and time domain specifications – Determination of closed loop response from open loop response – Stability analysis – Bode plot –Polar Plot- Routh Hurwitz criterion – Nyquist stability criterion.

UNIT IV	CONTROLLERS AND COMPENSATORS DESIGN	9

Needs of Controller–Implementation of P,PD,PI and PID controller using OPAMP, Effects of controller in feedback system, Effect of adding poles and zeros – Lag, lead and lag-lead networks – Lag, lead and lag-lead compensators design using Bode plot – Design of state feedback controller.

UNIT V	STATE VARIABLE ANALYSIS	9

Concept of state variables – State models for linear and time invariant Systems – Different forms of state model – Solution of state equation - State transition Matrix and properties – Controllability and Observability – State model for Discrete time system.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Nagarath, I.J. and Gopal, M., "Control Systems Engineering", New Age International Publishers, 2017, 6th edition.
2.	Norman S Nise, 'Control Systems Engineering', Wiley, 2015, 7thEdition.

REFERENCE BOOKS

1.	M. Gopal, "Control Systems, Principles and Design", 4th Edition, Tata McGraw Hill, New Delhi, 2012.
2.	S.K.Bhattacharya, Control System Engineering, 3rd Edition, Pearson, 2013.
3.	Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Prentice Hall, 2012.
4.	K. Ogata, "Modern Control Engineering", PHI, 2012, 5th edition
5.	S.Palani, AnoopK.Jairath, "Automatic Control Systems including MATLAB", ANE Books, 2013.

6.	Benjamin C. Kuo, “Automatic Control systems”, Wiley, 2014.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Derive transfer functions for electrical and mechanical systems	4
2	Analyze the root locus for a transfer function and interpret time response	4
3	Sketch Bode and Polar plots for a transfer function and verify the stability of a system by Routh-Hurwitz and Nyquist criteria	4
4	Implement a Controller and Design a Compensator using Bode plots	4
5	Solve a physical system with state variables	4

Bloom’s Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3					2			3	3	3
2	3	3	3	3					2			3	3	3
3	3	3	3	3					2			3	3	3
4	3	3	3	3					2			3	3	3
5	3	3	3	3					2			3	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22403	ELECTRICAL MACHINES II	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Construction, principle of operation and performance of induction machines.
- Starting and speed control of three-phase induction motors.
- Construction, principle of operation and performance of single phase induction motors and special machines.
- Construction and performance of salient and non – salient type synchronous generators.
- Principle of operation and performance of synchronous motor.

UNIT I	THREE PHASE INDUCTION MOTOR	9

Constructional details – Types of rotors - Principle of operation – Slip – Equivalent circuit – Torque-Slip characteristics – Condition for maximum torque – Three phase windings – Cogging and crawling – Losses and efficiency – No load and blocked rotor tests – Circle diagram –Double cage induction motors– Induction Generator.

UNIT II	STARTING, BRAKING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR	9

Need for starting – Types of starters – DOL, Rotor resistance, Auto transformer and Star-delta starters – Speed control – Voltage control, Frequency control and Pole changing – Cascaded connection – V/F control – Slip power recovery scheme – Braking of three phase induction motor: Plugging, dynamic braking and regenerative braking.

UNIT III	SINGLE PHASE INDUCTION MOTORS	9

Constructional details – Double field revolving theory and operation – Equivalent circuit – No load and blocked rotor test – Performance analysis – Starting methods – Capacitor- start & run Induction motor – Shaded pole induction motor– AC series motor – Hysteresis motor – Synchronous reluctance motor – Stepper motor.

UNIT IV	SYNCHRONOUS GENERATOR	9

Constructional details – Types of rotors Winding factors – EMF equation – Synchronous reactance – Armature reaction – Phasor diagram – Voltage regulation – EMF, MMF, ZPF and A.S.A methods – Synchronization – Synchronizing torque – Change of excitation and mechanical input - Parallel operation –- The Conditions Required for Paralleling - The General Procedure for Paralleling Generators– Two reaction theory – Slip test – Transient reactance.

UNIT V	SYNCHRONOUS MOTOR	9

Principle of operation – Torque equation – Operation on infinite bus bars – V and Inverted V curves – Power input and power developed equations – Starting methods – Current loci for constant power input, constant excitation and constant power developed – Hunting – frequency of oscillation – damper windings - Synchronous condenser.

TOTAL PERIODS: 45

TEXT BOOKS

1.	A.E. Fitzgerald, Charles Kingsley, Stephen. D. Umans, 'Electric Machinery', McGraw Hill publishing Company Ltd, 6th Education 2017.
2.	Vincent Del Toro, 'Basic Electric Machines' Pearson India Education, 2016.
3.	Stephen J. Chapman, 'Electric Machinery Fundamentals', McGraw Hill Education Pvt. Ltd, 4th Edition 2017.

REFERENCE BOOKS	
1.	D.P. Kothari and I.J. Nagrath, 'Electric Machines', McGraw Hill Publishing Company Ltd, 5th Edition 2017.
2.	P.S. Bhimbhra, 'Electrical Machinery', Khanna Publishers, 2nd Edition, 2021.
3.	M.N. Bandyopadhyay, 'Electrical Machines Theory and Practice, PHI Learning PVT LTD', New Delhi, 2009.
4.	B.R.Gupta, 'Fundamental of Electric Machines' New age International Publishers, 3rd Edition, Reprint 2015.
5.	Murugesh Kumar, 'Electric Machines', Vikas Publishing House Pvt. Ltd, 2002.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Determine the performance parameters of a Three phase Induction Motor by suitable tests	3
2	Evaluate different types of Starters and classify the Speed control schemes of Three phase Induction Motors	3
3	Characterize different types of Single phase Induction Motors and special machines	3
4	Predict the Regulation of an Alternator by different methods	3
5	Describe the Operation and Characteristics of Synchronous Motors	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	PO's												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3					2			3	3	3
2	3	3	3	3					2			3	3	3
3	3	3	3	3					2			3	3	3
4	3	3	3	3					2			3	3	3
5	3	3	3	3					2			3	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22404	MEASUREMENT AND INSTRUMENTATION	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Educate the fundamental concepts and characteristics of measurement and errors.
- Impart the knowledge on the functional aspects of measuring instruments.
- Infer the importance of various bridge circuits used with measuring instruments.
- Educate the fundamental working of sensors and transducers and their applications.
- Understand the structure of overall measurement and instrumentation with the knowledge of digital Instrumentation principles.

UNIT I	INTRODUCTION TO MEASUREMENTS	9

Measurements –types–Classification and applications of instruments – Elements of a generalized measurement system – Static and Dynamic characteristics – Errors in measurement –Statistical evaluation of measurement data- Instrument standards.

UNIT II	ANALOG INSTRUMENTS	9

Classification of instruments – Moving Coil and Moving Iron meters – Induction type, Dynamometer type Wattmeters – Energy meter – Megger – Instrument transformers (CT & PT), Instrumentation Amplifier.

UNIT III	COMPARATIVE METHODS OF MEASUREMENTS	9

D.C potentiometers, D.C (Wheat stone, Kelvin and Kelvin Double bridge) & A.C bridges (Maxwell, Anderson and Schering bridges), transformer ratio bridges, self-balancing bridges. Interference & screening – Multiple earth and earth loops – Electrostatic and electromagnetic Interference – Grounding techniques.

UNIT IV	DIGITAL INSTRUMENTS, STORAGE AND DISPLAY DEVICES	9

Digital Multimeter, Energy meter, frequency meter, Phase meter,SD Card and tape – Recorders, digital plotters and printers, digital CRO, LED, LCD & Dot matrix display – Data Loggers.

UNIT V	TRANSDUCERS AND DATA ACQUISITION SYSTEMS	9

Classification and selection of Transducers – Resistive, Inductive and Capacitive transducer, Ultrasonic sensor, Piezoelectric, Hall effect and Optical Transducer – Smart Sensors. DSO – Introduction to PLC, SCADA, IOT and Introduction to Virtual Instrumentation using Lab view.

TOTAL PERIODS: 45

TEXT BOOKS

1.	A.K. Sawhney, PuneetSawhney ‘A Course in Electrical & Electronic Measurements & Instrumentation’, Dhanpat Rai and Co, New Delhi, Edition 2015.
2.	H.S. Kalsi, ‘Electronic Instrumentation’, Tata McGraw-Hill, New Delhi, 2017.

REFERENCE BOOKS

1.	M.M.S. Anand, ‘Electronics Instruments and Instrumentation Technology’, Prentice Hall India, New Delhi, 2013.
2.	W.Bolton, Programmable Logic Controllers, Elseiver, 2010, 5th Edition.
3.	R.B. Northrop, ‘Introduction to Instrumentation and Measurements’, Taylor & Francis, New Delhi, 2008.
4.	E. O. Doebelin and D. N. Manik, “Measurement Systems – Application and Design”, Tata McGraw-Hill, New Delhi, 2007.
5.	R. K. Rajput, “Electrical and Electronics Measurements and Instrumentation”, Chand Pub, 2016.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Explain the Measurements in Engineering	5
2	Examine the structural elements of various Instruments	4
3	Estimate the unknown resistance, Inductance and Capacitance by using Bridges	5
4	Categorize the concept of Digital Instrumentation and Virtual Instrumentation	3
5	Apply the concepts of Sensors/Transducers	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**PO's**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	2	3			2	3	2		3	2	3
2	3	3	2	2	3			2	3	2		3	2	3
3	3	3	2	2	3			2	3	2		3	2	3
4	3	3	2	2	3			2	3	2		3	2	3
5	3	3	3	2	3			2	3	2		3	2	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22411	ANALOG ELECTRONICS LABORATORY	L T P C
		0 0 3 1.5

COURSE OBJECTIVES

- To familiarize students with the basic operation of operational amplifier and its design.
- To Provide knowledge on non-linear applications of op-amp, active filter design and A/D and D/A converter.
- To develop the acquaintance on the various applications of 555 Timer /PLL/Regulator ICs.
- To enrich the students with concepts of PCB fabrication and simulators.

LIST OF EXPERIMENTS

Linear applications of Op-amp	
1.	Inverting Amplifier, Non-Inverting Amplifier and Differential Amplifier
2.	Instrumentation Amplifier
3.	Differentiator and Integrator
Non-Linear applications of Op-amp	
4.	Comparator
5.	Clipper and Clamper
6.	Precision rectifier
7.	Multivibrators and Triangular wave generator
Data converters	
8.	Analog to digital converter and Digital to analog converter
Active Filters	
9.	Low pass filter and High pass filter
Special ICs Applications	
10.	Astable and Monostable Multivibrators using NE/SE 555 Timer IC
11.	Frequency multiplication using NE/SE 565 PLL IC
12.	Design and Implementation of High and Low Voltage Regulator using IC723
Simulation and PCB Design	
13.	Simulation study of PN Junction diode using COMSOL Multiphysics software.
14.	Design and develop a PCB Layout for given op-amp circuit using suitable software and fabrication tool.

TOTAL PERIODS:45

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Design and implement the various linear and non- linear circuits operational amplifier	4
2	Analyze the frequency response characteristics of active filter	4
3	Design and analyze the application circuits of 555Timer/ NE/SE 565 PLL /Regulator (723)ICs and implement A/D converter	4
4	Simulate and analyze various electrical behaviors of PN diode and FET using COMSOL Multiphysics tool	4
5	Design the PCB layout using Proteous simulator and fabricate PCB for any given application	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX														
COs	**PO's**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	2	3			2	2	2		2	2	
2	3	3	3	2	3			2	2	2		2	2	2
3	3	3	3	2	3			2	2	2		2	2	2
4	3	3	3	2	3			2	2	2		2	2	2
5	3	3	3	2	3			2	2	2		2	2	2
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														

LABORATORY REQUIREMENTS FOR A BATCH OF 30 STUDENTS		
SL.NO	**DESCRIPTION OF EQUIPMENTS**	**QUANTITY REQUIRED**
1.	Regulated Power supply	15
2.	CRO 30MHz	6
3.	DSO	4
4.	Function Generator	5
5.	Digital Multimeter	10
6.	Bread board	10
7.	Various IC	Each 10
8.	Resistors of various ranges	10
9.	Capacitors of various ranges	10
10.	Simulation software	1
11.	Connecting wires	As required

EE22412	CONTROL SYSTEMS AND INSTRUMENTATION LABORATORY	L T P C
		0 0 3 1.5

COURSE OBJECTIVES

- Identify the transfer function parameter and state space equation of the system and to assess the system dynamic response.
- Assess the system performance using frequency and time domain analysis and methods for improving it.
- Design various controllers and compensators to improve system performance.
- Measure unknown passive parameters using bridges and understand ladder program
- Assess the dynamic characteristics of sensors and understand the calibration of measuring instruments.

LIST OF EXPERIMENTS

Control systems:	
1.	Determination of Transfer function parameters of DC shunt Motor and DC Generator
2.	a)Determination of speed – torque characteristics of AC Servomotor and to obtain its transfer function parameters b)Study of Synchro transmitter and receiver
3.	Time response analysis of first and second order system for various standard input and stability analysis of linear time invariant system using MATLAB software.
4.	Design of Lag and Lead compensator
5.	Simulation and Experimental Verification to study the effect of P, PI, PD and PID controller on the step response of a feedback control system
6.	Controllability and Observability tests for continuous time domain systems using MATLAB software.
Instrumentation:	
7.	Measurement of the unknown Resistance(Wheat stones and Kelvin's Bridge)
8.	Measurement of the unknown inductance and capacitance (Anderson's and Schering Bridge)
9.	Calibration of Measuring Instruments and current transformer
10.	Dynamic characteristics of Sensors/Transducers (a)Temperature (b) Pressure (c) Displacement (d) Optical (e) Strain (f) Flow
11.	Study and development of the Ladder program for Logic gates using Programmable Logic Controller

TOTAL PERIODS:45

REFERNCE BOOKS

1.	K. Ogata, 'Modern Control Engineering', Pearson Education India publisher, 2015, 5th edition.
2.	A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, New Delhi, Edition 2015.

COURSE OUTCOMES		
Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Predict the transfer function parameter of the DC Motor and Generator	4
2	Apply the various time and frequency domain techniques to assess the stability	4
3	Test the system controllability and observability using state space representation and applications of state space representation to various systems	4
4	Use AC/DC bridge for accurate measurements of R, L and C values	4
5	Calibrate various measuring instruments and draw the dynamic characteristics of sensors/transducers	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	2	3	3		3	2			2	3	3
2	3	3	3	2	3	3		3	2			2	3	3
3	3	3	3	2	3	3		3	2			2	3	3
4	3	3	3	2	3	3		3	2			2	3	3
5	3	3	3	2	3	3		3	2			2	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

LABORATORY REQUIREMENTS FOR A BATCH OF 30 STUDENTS		
SL.NO	**DESCRIPTION OF EQUIPMENTS**	**QUANTITY REQUIRED**
1.	Design of PID controller kit	1
2.	DC Shunt motor	1
3.	DC Generator	1
4.	AC Servo motor with load and speed sensor kit	1
5.	Synchro -Transmitter and Receiver with voltmeter kit	1
6.	MC/MI Voltmeter	6
7.	MC/MI Ammeter	6
8.	Lag-Lead compensator design kit	1
9.	Digital storage Oscilloscope	4
10.	2MHz Function Generator	2
11.	Lamp Load	1
12.	Personal computers with MATLAB software	10
13.	Rheostats	6
14.	CRO Probe	2
15.	Bread board	3

16.	Connecting wires/Patch cords	As required
17.	Kelvin Double bridge kit	1
18.	Wheat stone Bridge kit	1
19.	Anderson Bridge kit	1
20.	Schering Bridge kit	1
21.	LVDT Kit	1
22.	Kit assembly of Pressure Sensor/Temperature sensor/ Level sensor/Optical sensor	1
23.	PLC with Process control kit	1
24.	Current Transformer	1
25.	Energy meter	1
26.	Multimeter	6
27.	Various range of Unknown Resistance/Inductance/Capacitance	Each 10
28.	Wattmeter	2
29.	Galvanometer	1
30.	Stopwatch	1
32.	Autotransformer	1
33.	Regulated Power Supply	3
34.	CRO/DSO	2
35.	WPL software 2.47	-

EE22413	ELECTRICAL MACHINES II LABORATORY	L T P C
		0 0 3 1.5

COURSE OBJECTIVES

- Familiarize the students with the operation of synchronous machines and induction machines and equip them with experimental skills.

LIST OF EXPERIMENTS	
1.	Regulation of Three Phase Alternator by EMF and MMF methods
2.	Regulation of Three Phase Alternator by ZPF and ASA methods
3.	Regulation of Three Phase salient pole Alternator by slip test
4.	V and Inverted V curves of Three Phase Synchronous Motor
5.	Load test on Single Phase and Three Phase Induction Motor (Cage & Slip ring)
6.	Equivalent circuit parameters of Three Phase Induction Motor by no load and blocked rotor tests
7.	Equivalent circuit parameters of Single Phase Induction Motor by no load and blocked rotor tests
8.	Study of braking methods of Three Phase Induction Motor
9.	Speed control of Induction motor by different methods
10.	Synchronization of Alternator with Infinite Bus-bar
11.	Load Test on Three Phase Alternator
12.	Study of Induction Generator (Stand-alone and Grid-connected)
	TOTAL PERIODS:45

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Understand and analyze EMF and MMF methods	5
2	Analyze the characteristics of V and Inverted V curves	4
3	Hands-on experience of conducting various tests on alternators and obtain their performance indices using standard analytical as well as graphical methods	3
4	Hands-on experience of conducting various tests on induction motors and obtaining their performance indices using standard analytical as well as graphical methods	5
5	Calculate different types of losses	5

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX														
COs	**PO's**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3	2	2		2	3	3		3	3	3
2	3	3	3	3	2	2		2	3	3		3	3	3
3	3	3	3	3	2	2		2	3	3		3	3	3
4	3	3	3	3	2	2		2	3	3		3	3	3
5	3	3	3	3	2	2		2	3	3		3	3	3
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														

LABORATORY REQUIREMENTS FOR A BATCH OF 30 STUDENTS		
SL.NO	**DESCRIPTION OF EQUIPMENTS**	**QUANTITY REQUIRED**
1.	DC Shunt Motor Coupled with Three phase cylindrical rotor alternator	2
2.	DC Shunt Motor Coupled with Three phase salient-pole alternator	1
3.	DC Shunt Motor Coupled with Three phase cage induction motor	1
4.	Synchronous Induction motor	1
5.	Single Phase Induction Motor with Loading Arrangement	2
6.	Three Phase cage Induction Motor with loading Arrangement	4
7.	Three phase slip ring induction motor with loading arrangement	2
8.	Rotor resistance panel for slip ring induction motor	1
9.	AC drive for speed control of induction motor	1
10.	Static Kramer drive	1
11.	Dynamic braking panel	1
12.	Tachometer -Digital/Analog	12
13.	Single Phase Auto Transformer	2
14.	Three Phase Auto Transformer	5
15.	Single Phase Resistive Loading Bank	2
16.	Three Phase Resistive Loading Bank	3
17.	Three phase Capacitor Bank	2
18.	Three phase Inductive load	1
19.	TPDT switch	2
20.	Wattmeter	12
21.	Rheostats	15
22.	Ammeters	20
23.	Voltmeters	20

SEMESTER-V

EE22501	MICROCONTROLLERS AND PROGRAMMING	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To realize the architecture and programming aspects of 8051 microcontrollers.
- To impart in depth knowledge on functional aspects and develop the programming skills using 8051 microcontrollers.
- To acquire skills in Embedded 'C' programming of 8051 microcontrollers.
- To acquire knowledge on architecture of ARM 32-BIT microcontrollers.
- To build application programs of ARM 32-BIT microcontrollers.

UNIT I	8051 MICROCONTROLLERS	9

Historical background of Microprocessor based personal computer system. Difference between a microprocessor and a microcontroller. 8051 Architecture – Pin details- Timing Diagram - Memory – I/O Ports - Counters/Timers – Interrupts - Serial communication.

UNIT II	8051 ASSEMBLY LANGUAGE PROGRAMMING	9

Instruction set of 8051 - Addressing modes - Assembly language Programming: Arithmetic operations, logic operations, Look up tables, Subroutines, Timer and Serial Port. Interfacing 8051 microcontroller with: Keyboard and Display (LED, LCD), Stepper Motor, AC servo motor, Washing Machine Control, LM35 Temperature Sensor, IR Sensor, PIR Motion Sensor, Traffic Light Control and Waveform Generation.

UNIT III	8051 EMBEDDED 'C' PROGRAMMING	9

Introduction to IDE – Embedded C Data types- Programming structure- reading and writing data from/to parallel ports – Timer/Counter programming – Interrupt handling – Serial port programming - 8051 Interfacing with peripherals using Embedded 'C': Matrix Keyboard, LCD, 7-segment LED Display - Familiarization with tools (Keil uVision IDE, STM32CUBE IDE, Flash Magic and Proteus Simulator).

UNIT IV	ARM 32-BIT MICROCONTROLLER	9

ARM – ARM Design Philosophy and RISC Architecture, Programmer's Model - ARM Cortex M, Cortex M Architecture - ARM Cortex-M Internals and Debugging - Pipelining – Instruction set, thumb instruction - ARM cortex M0 architecture - I2C, SPI Protocol configuration, its Peripheral and Modules - Study of CAN.

UNIT V	INTERFACING ARM (STM32)	9

GPIO Configuration, Driving De-initialization, Interfacing IO devices and its type – LEDs, Switches, Buzzer. Interrupt - Interrupt Priority Levels - UART Initialization - UART communication in polling Mode and Interrupt Mode, Timers, PWM, ADC. Analog Sensors and its Types (Ultrasonic Sensor, Temperature, Humidity, Soil Moisture Sensor, PIR sensor).

TOTAL PERIODS: 45

TEXT BOOKS

1.	Alexander G Dean, 'Embedded Systems Fundamentals with Arm Cortex-M based Microcontrollers: A Practical Approach Nucleo-F091RC', Arm Education Media, 2021, 2nd Edition.
2.	Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinley, 'The 8051 Microcontroller and Embedded Systems', Pearson Education, 2008, Fifth impression 2011, 2nd Edition.

REFERENCE BOOKS	
1.	Ariel Lutenberg, Pablo Gomez and Eric Pernia, 'A Beginner's Guide to Designing Embedded System Applications on Arm Cortex-M Microcontrollers', Arm Education Media, 2021, 2nd Edition.
2.	Warren Gay, 'Beginning STM32: Developing with Free RTOS, libopencm3 and GCC', Apress,2018, 1st Edition.
3.	Donald Norris, 'Programming with STM32: Getting Started with the Nucleo Board and C/C++ (ELECTRONICS)', McGraw Hill TAB, 2018, 2nd Edition.
4.	Shujen Chen, Eshragh Ghaemi, Muhammad Ali Mazidi, 'STM32 Arm Programming for Embedded Systems', Microdigitaled, 2018,1st Edition.
5.	Kenneth J. Ayala., 'The 8051 Microcontroller', Thompson Delmar Learning, 2012, 3rd Edition

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Analyze the interconnection of peripherals with CPU, RAM and ROM of 8051 microcontroller.	4
2	Analyze and apply the knowledge if instructions and programming model of 8051 microcontroller to develop programs.	4
3	Analyze and apply the Embedded C programming concepts to 8051 microcontroller applications and develop the systems using simulation software.	4
4	Analyze the architecture difference between 8051 microcontroller and ARM Microcontroller.	4
5	Develop a suitable programming model using Embedded C programming in ARM 32-bit microcontroller for various applications.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2											
2	3	3	2	3	3									
3	3	3	2										3	2
4	3	3	2	2	3	3	2				2	3	3	2
5	3	3	2	2	3	3	2				2	3	3	2

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22502	POWER ELECTRONICS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Conceptualize the principles underlying various Power Semiconductor Devices.
- Acquire analytical skills for designing a Power converter circuit.
- Learn the operation, switching techniques and basics topologies of DC-DC switching regulators.
- Analyse the operation of inverters, switching techniques implemented in recent technology.
- Acquire knowledge about application of Power Electronic converters in Power Control applications.

UNIT I	POWER SEMI-CONDUCTOR DEVICES	9

Study of switching devices, Diode, SCR, TRIAC, GTO, BJT, MOSFET, IGBT- Static and dynamic characteristics - Triggering and commutation methods for SCR - design of driver and snubber circuit.

UNIT II	PHASE-CONTROLLED CONVERTERS	9

1-pulse, 2-pulse, 3-pulse and 6-pulse converters with R. R-L and R-L-E loads- performance parameters-detailed analysis –Effect of source inductance –gate circuit schemes for phase control–dual converters - Introduction to design of converter for DC motor speed control.

UNIT III	DC - DC CONVERTERS	9

Step-down and step-up chopper-control strategy- non-isolated dc-dc converters: Analysis of buck and boost converters, Isolated dc-dc converters: fly-back and forward topologies - Introduction to design of converter for SMPS topologies.

UNIT IV	INVERTERS	9

Single phase and three phase voltage source inverters (both 120° mode and180° mode)–Voltage& harmonic control - PWM techniques: Sinusoidal PWM, modified sinusoidal PWM – multiple PWM – Current source inverter- Introduction to Multilevel Inverters- Design and Application of Inverters.

UNIT V	AC - AC CONVERTERS	9

Single phase and three phase AC voltage controllers– Power Factor Control –Multistage sequence control - single phase and three phase cyclo-converters –Introduction to Matrix converters - Introduction to speed control of Induction Motor -Design of AC voltage controller.

TOTAL PERIODS: 45

TEXT BOOKS

1.	M.H. Rashid, 'Power Electronics Circuits, Devices and Applications', Pearson Education, PHI, New Delhi, 2017, 4th Edition.
2.	Dr. P.S.Bimbhra,'Power Electronics' Khanna Publishers,2022, 7th Edition.

REFERENCE BOOKS

1.	L. Umanand, 'Power Electronics Essentials and Applications', Wiley, 2010.
2.	Joseph Vithyathil, 'Power Electronics, Principles and Applications', McGraw Hill Series, 6thReprint, 2013.
3.	M.D. Singh and K.B. Khanchandani, 'Power Electronics', Mc Graw Hill India, 2013.
4.	Philip T. Krein, 'Elements of Power Electronics', Oxford University Press, 2009 Edition.
5.	Ned Mohan, Tore. M. Undeland, William. P.Robbins, 'Power Electronics: Converters, Applications and Design', John Wiley and sons, ,2007, 3rd edition.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to:		
COs	**STATEMENTS**	**RBT LEVEL**
1	Choose suitable power electronic devices for high power applications and to design driver and snubber circuits.	4
2	Evaluate the performance parameters of phase controlled converters.	5
3	Analyse and design various DC-DC converter topologies.	4
4	Evaluate the performance parameters of Inverters and various PWM techniques.	4
5	Understand and design speed control methods for motors through the study of AC-AC converters.	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	2	2			1	1	2		3	3	3
2	3	3	3	2	3			1	1	2		3	3	3
3	3	3	3	2	3			1	1	2		3	3	3
4	3	3	3	2	3			1	1	2		3	3	3
5	3	3	3	2	3			1	1	2		3	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22503	POWER SYSTEM ANALYSIS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Develop power system network models under steady state conditions
- Acquire knowledge on power flow solution methods
- Model and analyze the power system under faulted conditions
- Model and analyze the stability of power system

UNIT I	POWER SYSTEM MODELLING	9

Introduction of Modern Power System – Power system components - Single line diagram - Assumptions – Per phase equivalent circuit - Per unit representation - Formation of Network Admittance Matrices using Bus inspection and Singular transformation – Formation of Impedance Matrices- Zbus Building Algorithm.

UNIT II	LOAD FLOW STUDIES	9

Overview - Real and Reactive Power Injected in a Bus - Classification of Buses - Preparation of Data and Load Flow Study by Gauss-Seidel Method - Newton-Raphson Method - Fast Decoupled method- Slack bus real and reactive power, line flow and loss calculation – Case studies through Simulation software.

UNIT III	SYMMETRICAL FAULT ANALYSIS	9

Overview - Fault in an AC Circuit - Short Circuit in an Unloaded Synchronous Generator - Symmetrical Fault in a Power System - Calculation of Fault Current using Impedance Diagram and Z bus Matrix - Current limiting reactor - Circuit Breaker Selection - Case studies through Simulation software.

UNIT IV	UNSYMMETRICAL FAULT ANALYSIS	9

Overview - Symmetrical Components and Representation of Faulted Networks - Fault Current Computation using Sequence Networks - Single-Line-to-Ground Fault - Line-to-Line Fault - Double- Line -to Ground Fault - Open conductor fault - Case studies through Simulation software.

UNIT V	STABILITY ANALYSIS	9

Introduction to SMIB system – classification of stability – Steady state and Transient state stability - Swing Equation - Equal Area Criterion - Case study on sudden change in mechanical input, loss of line and short circuit - Formation of system state matrix – Numerical solutions by Runga - Kutta 4th order method - Multi-machine Stability- Case studies through Simulation software.

TOTAL PERIODS: 45

TEXT BOOKS

1.	D P Kothari, I J Nagrath and R K Saket., 'Modern Power System Analysis', Tata McGraw-Hill, 2022, 5th Edition.
2.	Hadi Saadat, 'Power System Analysis', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2010, 3rd Edition.

REFERENCE BOOKS

1.	Kundur P., 'Power System Stability and Control', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2010, 2nd Edition.
2.	John J. Grainger and W.D. Stevenson Jr., 'Power System Analysis', Tata McGraw-Hill, Sixth reprint, 2017, 2nd Edition.
3.	Pai M A, 'Computer Techniques in Power System Analysis', Tata Mc Graw-Hill Publishing Company Ltd., New Delhi, 2007.
4.	J. Duncan Glover, Mulukutla S. Sarma, Thomas J. Overbye, 'Power System Analysis and Design', Cengage Learning, 2019, 6th Edition.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to:		
COs	**STATEMENTS**	**RBT LEVEL**
1	Demonstrate modelling of power system components and construct network matrices.	3
2	Formulate the power flow problem and apply numerical solution methods.	3
3	Analyze symmetrical short circuit faults in a power system	4
4	Analyze unsymmetrical short circuit faults in a power system	4
5	Apply equal area criterion and numerical solution method to stability problem.	3
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	1	2		1		1	1	2	2	1	3
2	3	3	3	2	2		1		1	2	2	2	1	3
3	3	3	3	2	2	2	1		1	2	2	2	1	3
4	3	3	3	2	2	2	1		1	2	2	2	1	3
5	3	3	3	2	2	2	1		1	2	2	2	1	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

IT22551	PROGRAMMING AND DATA STRUCTURES	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To comprehend the fundamentals of objectoriented programming, particularly in JAVA.
- To explore advanced Java concepts such as inheritance, polymorphism, encapsulation, and abstraction, and apply them in designing object-oriented solutions.
- To introduce linear data structures and their applications.
- To introduce non-linear data structures and their applications.
- Learn to implement sorting and searching algorithms.

UNIT I	INTRODUCTION TO JAVA	9

Basic of Java – Class and Objects, Packages in Java, Data Types in Java, Variables, Methods, Constructor, Modifiers, Static Keyword, Final Keyword, Inner Class, Super and this keyword, Encapsulation

UNIT II	OOPS CONCEPTS	9

Inheritance in Java - Is-A-Relationship - Aggregation and Composition - Types of Inheritance, Polymorphism in Java - Types of Polymorphism - Static and Dynamic Binding - Method overloading - Method Overriding, Abstraction in Java - Abstract Class - Abstract method - Interface in Java - Nested interface.

UNIT III	LINEAR DATA STRUCTURES	9

Abstract Data Types (ADTs) – List ADT – array-based implementation – linked list implementation — singly linked lists –Polynomial Manipulation - Stack ADT – Evaluating arithmetic expressions- Queue ADT – Circular Queue implementation.

UNIT IV	NON-LINEAR DATA STRUCTURES	9

Trees – Binary Trees – Binary tree representation and traversals - The Search Tree ADT - Binary Search Trees- – Application of trees – Graph and its representations – Graph Traversals – Representation of Graphs – Breadth-first search – Depth-first search- Dijkstra's shortest path algorithm.

UNIT V	SORTING AND SEARCHING	9

Sorting algorithms: Bubble sort- Insertion sort - Quick sort - Merge sort - Selection sort, Searching: Linear search –Binary Search.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Herbert Schildt, 'Java: The Complete Reference', McGraw-Hill Education, 2017.
2.	Mark Allen Weiss, 'Data Structures and Algorithm Analysis in C++', Pearson Education, 2017, 2nd Edition.

REFERENCE BOOKS

1.	Sierra, Kathy, and Bert Bates. 'Head First Java', O'Reilly Media, 2021.
2.	Horstmann, Cay S., and Gary Cornell. 'Core Java VolumeIFundamentals'. Pearson Education, 2016.
3.	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, 'Introduction to Algorithms', MIT Press, 2009, 3rd Edition.
4.	Bjarne Stroustrup, 'The C++ Programming Language',Pearson Education, 2018, 4th Edition.
5.	Ellis Horowitz, Sartaj Sahni and Dinesh Mehta, 'Fundamentals of Data Structures in C++', Galgotia Publications, 2008, 2nd Edition.

COURSE OUTCOMES		
Upon the successful completion of the course, the students will be able to:		
COs	**STATEMENTS**	**RBT LEVEL**
1	Evaluate the design of a Java program in terms of its class structure, object interactions, and encapsulation of data.	4
2	Design and develop robust and scalable object-oriented solutions using inheritance, polymorphism, and abstraction.	5
3	Develop programs to implement linear data structures such as stacks, queues, linked lists, etc	5
4	Apply non-linear data structures to solve various problems.	3
5	Analyze the different methods of organizing large amount of data.	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	2	1			1					2	
2	3		3	2	1			1	2		3		2	
3	3		3	2	1	1	1	1	2					
4	3					1	1	1						
5	3	3				1	1	1			3			

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22511	MICROCONTROLLERS AND PROGRAMMING LABORATORY	L T P C
		0 0 3 1.5

COURSE OBJECTIVES

- To write ALP using instruction sets of 8051 microcontroller.
- To Interface 8051 microcontroller with LED, Keyboard and Motors.
- To establish connection with Personal Computer and 80851 microcontrollers.
- To practice Simulators/Emulators/open source (STM32CUBE IDE) with ALP and Embedded C.
- To write Embedded C coding to Program ARM microcontroller.

LIST OF EXPERIMENTS

8051 Microcontroller	
1.	Simulation and hardware implementation of 16-Bit arithmetic operations: addition/ subtraction/multiplication/division using 8051.
2.	Simulation and hardware implementation of interfacing Experiments with 8051 (i)A/D Interfacing (ii) D/A Interfacing.
3.	Simulation and hardware implementation of interfacing seven segment LED and Keyboard with 8051.
4.	Simulation and hardware implementation of establishing Communication between 8051 microcontroller and PC using UART.
ARM controller	
5.	Simulation and hardware implementation of read toggle switch and control LED.
6.	Simulation and hardware implementation of change between color of multicolor LED on Button press (GPIO Interrupt)
7.	Simulation and hardware implementation of set a timer and toggle LED once a timer interrupt occurs.
8.	Simulation and hardware implementation of sequential count increment over display on button press.
9.	Simulation and hardware implementation of read binary number from switch inputs and display equivalent hexadecimal on 7 segment display.
10.	Simulation and hardware implementation of reading potentiometer value from ADC and send data over UART to PC.
11.	Simulation and hardware implementation of read numeric data over UART from PC and show over 7 segment display.
12.	Simulation and hardware implementation of read key press from matrix keypad and show the digit over 7 segment display.
13.	Simulation and hardware implementation of control fan speed using PWM. Program three different duty cycle and change speed on button press.
14.	Simulation and hardware implementation of read temperature from I2C temperature sensor and send data over UART to PC.
	TOTAL PERIODS:45

COURSE OUTCOMES		
Upon the successful completion of the course, the students will be able to:		
COs	**STATEMENTS**	**RBT LEVEL**
1	Analyze and apply the knowledge if instructions and programming model of 8051 microcontroller to develop Arithmetic programs.	4
2	Analyze and apply the knowledge if instructions and programming model of 8051 microcontroller to develop programs using stack, program counter, and status register.	4
3	Interface 8051 microcontroller with Personal Computer through UART.	4
4	Analyze and apply the Embedded C programming concepts to ARM microcontroller.	4
5	Develop projects in ARM microcontroller using Embedded C programming.	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2					1		2		3		
2	3	3	2	3	3			1		2		3		
3	3	3	2		3			1		2		3	3	2
4	3	3	2	3	3	3	2	1		2	2	3	3	2
5	3	3	2	3	3	3	2	1		2	2	3	3	2

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

LABORATORY REQUIREMENTS FOR A BATCH OF 30 STUDENTS		
SL.NO	**DESCRIPTION OF EQUIPMENTS**	**QUANTITY REQUIRED**
1.	8051 Microcontroller Trainer Kit with power supply	15
2.	LED and Keyboard interfacing Kit.	5
3.	STM32 Arm Controller	10
4.	Personal Computer	10
5.	Temperature Sensor, DC fan, Keypad and seven segment display	Each 5

EE22512	POWER ELECTRONICS LABORATORY	L T P C
		0 0 3 1.5

COURSE OBJECTIVES

- Study the power electronics switching devices characteristics.
- Study the operation of various power converter circuits
- Design and analyze AC voltage controller
- Learn the operation of various converters and inverters through simulation.
- Design, simulate and implement inverter for UPS application.

LIST OF EXPERIMENTS

1.	Characteristics of SCR and TRIAC
2.	Characteristics of MOSFET and IGBT
3.	AC to DC half & fully controlled converter
4.	IGBT based single phase PWM inverter
5.	IGBT based three phase PWM inverter
6.	Design of AC Voltage controller
7.	Simulation of 1Φ & 3Φ semi and full converters
8.	Simulation of buck and boost DC – DC converter
9.	Simulation of AC voltage controller, 1Φ sine wave inverter and 3Φ Inverter with 180 degree and 120degree mode of operation
10.	Design, simulation and implementation of forward converter
11.	Design, simulation and implementation of fly-back converter
12.	Design, simulation and implementation of inverter for UPS applications

TOTAL PERIODS:45

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Analyse the performance characteristics of power semiconductor devices.	4
2	Illustrate the functioning of power converter circuits with different load conditions.	4
3	Devise various control techniques for DC and AC drives.	4
4	Simulate and evaluate the performance of power converter with various load conditions.	4
5	Design the converter, inverter and chopper for applications such as SMPS and UPS.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	2	3			2	3	3		3	3	2
2	3	3	3	2	3			2	3	3		3	3	3
3	3	3	3	2	3			2	3	3		3	3	3
4	3	3	3	2	3			2	3	3		3	3	3
5	3	3	3	2	3			2	3	3		3	3	3
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														

LABORATORY REQUIREMENTS FOR A BATCH OF 30 STUDENTS		
SL.NO	**DESCRIPTION OF EQUIPMENTS**	**QUANTITY REQUIRED**
1.	Device characteristics (for SCR, MOSFET, TRIAC and IGBT kit with built-in / discrete power supply and meters)	2
2.	Single phase SCR based half controlled converter and fully controlled converter alongside built-in/separate/firing circuit/module and meter	2
3.	IGBT based single phase PWM inverter module/Discrete Component	2
4.	IGBT based three phase PWM inverter module/Discrete Component	2
5.	SCR &TRIAC based 1 phase AC controller along with lamp or rheostat load	2
6.	MOSFET based Driver circuit for 3Φ Inverter	2
7.	Isolated DC-DC Converter -Flyback converter kit	1
8.	Isolated DC-DC converter -Forward Converter kit	1
9.	MOSFET switches	10
10.	Opto-couplers	10
11.	Breadboard	10
12.	Dual regulated DC power supply with common ground	5
13.	Digital Storage Oscilloscope	10
14.	Isolation Transformer	5
15.	Single phase Auto transformer	3
16.	Multi-meter	5
17.	LCR meter	2
18.	Rheostats of various ranges	2
19.	Inductance, Capacitance of various ranges	2 each
20.	DC and AC meters of required ranges	20
21.	Connecting wires and Patch cords	As required

IT22561	PROGRAMMING AND DATA STRUCTURES LABORATORY	L T P C
		0 0 3 1.5

COURSE OBJECTIVES

- Be familiar with java programming language.
- Learn to implement linear and non linear data structures.
- To implement various applications using different data structures.
- Learn to implement sorting and searching algorithms.

LIST OF EXPERIMENTS	
1.	Basic Programs of Java
2.	Programs on Inheritance
3.	Programs on polymorphism
4.	Programs on abstraction
5.	Implementation of Singly Linked List operations
6.	Implementation of Stack operations
7.	Implementation of Stack Applications
8.	Implementation of Queue operations
9.	Implementation of Circular Queue operations
10.	Implementation of Binary search Tree operations
11.	Implementation of Dijkstra's algorithm for Single Source Shortest Path problem.
12.	Implementation of Linear Search and Binary Search.
13.	Quick Sort, Merge Sort
	TOTAL PERIODS:45

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Design and implement JAVA programs.	5
2	Apply good programming design methods for program development on OOPS Concepts.	3
3	Implement operations in linear and non-linear data structures	3
4	Apply different data structures for solving real world problems.	3
5	Apply the various sorting and searching Algorithms	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	2	1			1					2	
2	3		3	2	1			1	2		3		2	
3	3		3	2	1	1	1	1	2					
4	3					1	1	1						
5	3	3				1	1	1			3			
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														

LABORATORY REQUIREMENTS FOR A BATCH OF 30 STUDENTS		
SL.NO	**DESCRIPTION OF EQUIPMENTS**	**QUANTITY REQUIRED**
1.	Standalone desktops with JDK (or) Server with JVM supporting 30 terminals or more.	30

SEMESTER VI

EE22601	DIGITAL SIGNAL PROCESSING	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Classify signals and systems, explain the mathematical representations and determine the response using Z transform.
- Implement Discrete Fourier Transform from FT, and learn about its frequency response using Fast Fourier Transform algorithms.
- To study about the design of FIR filters.
- To study about the design of IIR filters.
- Introduction about the general purpose digital signal processors and special instructions.

UNIT I	DISCRETE-TIME SIGNALS AND SYSTEMS	10

Need and benefits of Digital Signal Processing - Sampling and Quantization of analog signals - Signal classification and basic operations - LTI system –Impulse response - Convolution sum and Correlation - I/O relationship - Determination of Impulse response and Step response using Z transformation - A Typical DSP system.

UNIT II	DISCRETE TRANSFORMS	8

Fourier Series and Fourier Transform - Discrete Fourier Transform (DFT) - Properties- DFT frequency spectrum - DIT - FFT and DIF - FFT radix2 algorithms- inverse FFT – linear filtering via circular convolution- Programs for DFT, FFT algorithms.

UNIT III	DESIGN OF FIR DIGITAL FILTERS	10

Characteristics and applications of FIR filters - FIR filter design using Window functions - Canonical forms of Realization – Programs for design the FIR filters.

UNIT IV	DESIGN OF IIR DIGITAL FILTERS	8

Characteristics and applications of IIR filters - Design techniques for analog filters - Frequency transformation - Digital IIR filter design: impulse invariant and bilinear transform methods - Canonical forms of Realization: direct, cascade, and parallel forms- Program for design the IIR filters.

UNIT V	GENERAL-PURPOSE DIGITAL SIGNAL PROCESSORS	9

Computer architectures for signal processors (TMS320C50 and TMS320C54X) - pipelining - hardware multiplier – accumulator - special instructions - Extended parallelism: SIMD, VLIW, and super scalar processing - Finite word length effects in IIR filters and FFT algorithms.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Lonnie C. Ludeman, 'Fundamental of Digital Signal Processing', Wiley India, New Delhi, 2014, 1st Edition.
2.	Emmanuel Ifeachor, Barrie W. Jervis, 'Digital Signal Processing, A practical approach', Pearson Education, New Delhi, 2015, 2nd Edition.

REFERENCE BOOKS

1.	John G Proakis, Dimitris G. Manolakis, 'Digital Signal Processing: Principles, Algorithms, and Applications', Pearson Education, New Delhi, 2018, 4th Edition.
2.	Sanjit K Mitra, 'Digital Signal Processing, A Computer based Approach', McGraw-Hill, New Delhi, 2013, 4th Edition.
3.	Monson H. Hayes, "Schaums Outline of Digital Signal Processing", McGraw-Hill Education,

	USA, 2011, 2nd Edition.
4.	Dimitris G. Manolakis, Vinay K. Ingle, "Applied Digital Signal Processing: Theory and Practice", Cambridge University Press, UK, 2011, 1st Edition.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Learn the classifications of signals with mathematical representation and determine the response of the system using Z transform	3
2	Analyse discrete transforms and evaluate its advancements using FFT algorithms	4
3	Design and evaluate the performance of FIR filters	5
4	Design and evaluate the performance of IIR filters	5
5	Understand the basic architecture of digital signal processors and analyze the finite word length effects	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2											
2	3	3	2	3	3									
3	3	3	2										3	2
4	3	3	2	3	3	3	2				2	3	3	2
5	3	3	2	3	3	3	2				2	3	3	2

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22602	INDUSTRIAL AUTOMATION AND NETWORKING (INDUSTRY SUPPORTED)	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Recapitulate the working of sensors and signal conditioning process.
- Study of components and circuit design associated with pneumatics and electro-pneumatics.
- Learn the operation and programming of PLCs and human machine interfaces.
- Obtain an overview of HMI, distributed control systems and SCADA.
- Familiarize with the interconnection and data exchange between PLCs, field devicesand supervisory units with different bus structures.

UNIT I	SENSORS AND MEASUREMENT SYSTEMS	9

Industrial Automation: Need, Types and Levels (Automation pyramid) - Sensors and measurement systems: position, temperature, pressure, force, displacement, speed, acceleration, flow and level - Signal conditioning and Processing of control variables - Concept of Industry 5.0: Smart sensors, IoT in automation.

UNIT II	PNEUMATICS AND ELECTRO-PNEUMATICS	9

Introduction to Fluid power – classification of air actuators, single acting and double acting cylinders - control valves for direction, pressure and flow - Air preparation - Circuit design: symbols, schematic, travel step diagram, control modes - sequence identification and control – Cascade method, KV mapping and Step counter method, simulation of drilling process - Electro-pneumatics: components, relay ladder diagram.

UNIT III	PLCs	9

PLC: Internal architecture, I/O modules, fixed and modular PLC – data types – memory – basics of redundancy – Scan cycle – Analog Scaling - PLC communication modules - Program development: Flow chart/Pseudocode, Bit instructions, Arithmetic functions, timers, counters, data transfer, PLC programming: Maintaining flow in oil refinery plant and Speed Control in Variable Frequency Drive.

UNIT IV	HMI, DCS AND SCADA	9

Control flow in Industry - HMI: Necessity and Role, configuring alarms, trends, basic design of graphics using text, numeric, toggle switches, sliders, function keys –- DCS: Architecture, local control unit, programming language, communication facilities, operator interface, engineering interfaces, Data logging and alarm logging - SCADA: redundancy in SCADA, soft tags count, mimic creation for a case study.

UNIT V	NETWORKING AND ROBOTICS	9

Networking of sensors, actuators and controllers – Industrial Communication Protocols: Fieldbus, Profibus, Profinet, Modbus, Ethernet IP, IEEE Standards - Introduction to Robotics, Work volume, End Effectors, Robotic sensors and Machine vision, Robotics in automation.

TOTAL PERIODS: 45

TEXT BOOKS

1.	S. Mukhopadhyay, S. Sen and A. K. Deb, ‘Industrial Instrumentation, Control and Automation’, Jaico Publishing House, 2013.
2.	Frank D Petruzella, ‘Programmable Logic Controllers’, McGraw Hill Inc, 2019.

REFERENCE BOOKS

1.	S. R. Deb and S. Deb, ‘Robotics Technology and Flexible Automation’, Tata McGraw Hill Education Pvt. Ltd, 2017.
2.	Steve Mackay, ‘Practical Industrial data networks: Design, Installation and Troubleshooting’, Elsevier Newnes, 2004.

3.	William C. Dunn, 'Fundamentals of Industrial Instrumentation and Process control', McGraw Hill, 2005.
4.	Anthony Esposito, 'Fluid power with applications', Pearson New International Edition, 2014.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Identify suitable sensors and design measurement system for process control applications	3
2	Configure a pneumatic/electro-pneumatic circuit for automating a process	3
3	Design and develop PLC ladder logic program for industrial sequence control cases	3
4	Program HMI, SCADA and interface with PLC for process monitoring and control	3
5	Network field devices with PLCs and postulate the basics of robotics	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3	1	1				1		2	3	
2	3	3	3	3	3	1				1		2	3	
3	3	3	3	3	3	1				1		2	3	
4	3	3	3	3	3	1				1		2	3	
5	3	2	3	2	2	1				1		2	3	

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22603	POWER SYSTEM OPERATION AND CONTROL	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Characterization of electrical power demand and understand load forecasting techniques.
- Develop the Load frequency model of multi area power system and to perform static and dynamic analysis
- Derive the Static excitation system model and to study the system level voltage control technique.
- Comprehend economic operation of power system and control strategies on power systems
- Acquire knowledge on computer control and operating states of power system

UNIT I	INTRODUCTION TO POWER SYSTEM OPERATION AND CONTROL	9

Characteristics of Modern Power Systems – Importance of power system interconnection- Major concern in power system design and operating criteria – Power to frequency (P-F) and Reactive power to Voltage (Q-V) control loops - Power system load variation - Load curves - Load forecasting - Quadratic and Exponential curve fitting techniques of load forecasting.

UNIT II	REAL POWER - FREQUENCY CONTROL	9

Primary Control of Frequency: Governors -Secondary Control of Frequency: Automatic Generation Control - control area concept – Load Frequency Control (LFC) of a single area system and multi-area system – Modeling - Static and dynamic analysis – State variable model - Integration of Economic Dispatch Control (EDC) with LFC control – LFC with distributed generation.

UNIT III	REACTIVE POWER–VOLTAGE CONTROL	9

Generation and absorption of reactive power - Voltage control –Static Excitation Systems – Modeling - Static and dynamic analysis - Stability compensation - Methods of voltage control: Shunt Compensation – Static Var Compensator (SVC) and Static Synchronous Compensator (STATCOM) – Tap changing Transformer - Voltage control with distributed generation.

UNIT IV	ECONOMIC OPERATION OF POWER SYSTEMS	9

Concepts of Unit Commitment and solution methods – Priority-list method – Forward dynamic programming approach -Unit commitment in deregulated environment. Economic Dispatch Problem - Control variables and constraints -Thermal System Dispatching with Network Losses Considered - Lambda-Iteration Method - Base point and Participation factors - Optimal Power Flow**.**

UNIT V	COMPUTER CONTROL OF POWER SYSTEMS	9

Indian Scenario, Functions of Energy control center, Phasor Measurements Unit (PMU) and Supervisory Control And Data Acquisition (SCADA)- PLCs and DCS -State estimation-Security assessment and security enhancement – State transition diagram showing various state transitions and control strategies - Normal and Alert State in a Power System - Preventive, Emergency and Restorative Control – Blackout - Power System Restoration- Applications of Artificial Intelligence in power system operation, control and planning.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Olle.I.Elgerd, 'Electric Energy Systems theory - An introduction', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2017, 2nd Edition.
2.	Allen. J. Wood and Bruce F. Wollenberg, 'Power Generation, Operation and Control', John Wiley & Sons, Inc., 2013, 3rd Edition.

REFERENCE BOOKS	
1.	Nagrath I.J. and Kothari D.P., 'Modern Power System Analysis', Tata McGraw-Hill, 2022, Fifth Edition.
2.	Kundur P., 'Power System Stability and Control, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2022, 2nd Edition.
3.	Hadi Saadat, 'Power System Analysis', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2010, 3rd Edition.
4.	Abhijit Chakrabarti, Sunita Halder, 'Power System Analysis Operation and Control', PHI learning Pvt. Ltd., New Delhi, 2010, 3rd Edition.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Examine the plant level control loops and load forecasting techniques.	3
2	Model and Analyze the load frequency control dynamics in power system	4
3	Model and Analyze the Excitation system and system level voltage control methods	4
4	Formulate and solve unit commitment and real power scheduling problems.	4
5	Identify the operating states of power system and apply suitable control strategies in a practical power system network.	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2	2	1	1	2		1	1	1		1	2	1	3
2	3	3	3	2	2	1	1	2	1	2	1	2	1	3
3	3	3	3	2	2	1	1	2	1	2	1	2	3	3
4	3	3	3	2	2	1	1	2	1	2	1	2	1	3
5	2	2	1	1	2		1	1	1	2	1	2	1	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

HS22511	INTERVIEW AND CAREER SKILLS LABORATORY	L T P C
	(COMMON TO ALL BRANCHES EXCEPT CE)	0 0 3 2

COURSE OBJECTIVES

- Build confidence and develop learners' language proficiency.
- Better learners' performance in competitive examinations.
- Improve learners' employability skills.
- Develop entrepreneurship skills.
- Expose learners to the use of professional English.

UNIT I	LISTENING AND SPEAKING SKILLS	12

Conversation Skills – types small talk, face to face and telephonic, formal and informal conversations – skills in presenting ideas and collating information during conference calls (one –to one and technical group / team) – academic and workplace situations –conversing with faculty/visiting faculty/guests/officials/employers and employees –group discussion – etiquette and dos and don'ts, turn taking –presentation skills –seminars and projects using digital tools; mock interview – etiquette and dos and don'ts– audio-visual interface for enhancement of listening and speaking skills. IELTS and TOEFL (Listening related exercises)

UNIT II	READING / SPEED READING, CRITICAL THINKING AND WRITING SKILLS	12

Reading Comprehension – general and scientific texts/articles/case studies from different or relevant fields of study for analysis and critical thinking; employability skills – writing job applications – cover letter accompanying résumé – types of business letters and email writing and etiquette; writing reports – statement of purpose – writing articles for publication style and format – creating blogs or company profiles – speed reading of voluminous reports / documents and exacting necessary information and abstract preparation including dissemination. IELTS and TOEFL(Reading related exercises)

UNIT III	ENGLISH FOR PROFESSIONAL EXAMINATIONS	12

Sentences, paragraphs and reading comprehension – vocabulary building – general and technical terms – contextual meaning – spelling – subject specific words – usage and user specific terminology. IELTS and TOEFL(Grammar and verbal exercises)

UNIT IV	ENTREPRENEURSHIP SKILLS	9

Introduction to entrepreneurship - fundamentals of entrepreneurial skills - developing leadership qualities and team work;– marketing strategies microcosmic and macrocosmic levels of product sales and survey – sector / industry appraisal and appreciation (review and understanding state of the nation / economy / environment / sector reports published) interaction and understanding the role of multilateral financial / institutional / industrial agencies such as World Bank, ADB, UNDP, CII - Influencing in Business Meetings - Active Listening and responding - Role-play - Strengthening – Negotiating/ Argumentative and Persuasive Skills - Defend a character/idea or attack it. - Networking Skills - engaging strangers in a conversation - introducing themselves, making small talk.

TOTAL PERIODS: 45

REFERENCE BOOKS

1.	'Business English Certificate Materials', Cambridge University Press.
2.	'Graded Examinations in Spoken English and Spoken English for Work', downloadable materials from Trinity College, London.
3.	'International English Language Testing System Practice Tests', Cambridge University Press.
4.	Interactive Multimedia Programs on Managing Time and Stress.
5.	Personality Development (CD ROM), Times Multimedia, Mumbai.

WEB SOURCES	
1.	http://www.slideshare.net/rohitjsh/presentationon group discussion
2.	http://www.washington.edu/doit/TeamN/present_tips.html
3.	http://www.oxforddictionaries.com/words/writingjobapplications
4.	http://www.kent.ac.uk/careers/cv/coveringletters.html
5.	http://www.mindtools.com/pages/article/newCDV_34.html

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COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Develop approaches for mastering international English language tests such as IETLS and TOEFL, as well as national-level competitive exams.	6
2	Make presentations and participate in Group Discussions.	6
3	Face interviews with confidence and develop strategies for negotiating job offers.	6
4	Build effective resumes, cover letters and professional emails to enhance job application success.	6
5	Explore strategies for scaling and growing entrepreneurial ventures.	6

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1										3				
2										3				
3										3				
4										3				
5										3				

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22611	INDUSTRIAL AUTOMATION LABORATORY	L T P C
		0 0 4 2

COURSE OBJECTIVES

- To familiarize with the simulation and implementation of pneumatic/hydraulic circuits.
- To know the PC-PLC interfacing configuration procedure.
- To understand sensors, PLC and HMI interfacing for process automation.
- To learn the industrial processes implementation using PLC and SCADA
- To acquaint knowledge onrobotics components, communication and programming.

LIST OF EXPERIMENTS

CIRCUIT DESIGN, SENSORS TECHNOLOGY AND PLC PROGRAMMING	
1	Design and implement the logic for the given pneumatic circuit in hardware and with simulation software.
2	Design and simulation of hydraulic circuit for a given sequential logic.
3	Design and implement the logic in PLC for the given pneumatic circuit in hardware and with simulation software.
4	Interfacing of transducer with HMI and PLC for monitoring the process variables: Temperature, Pressure, Level, Weight, Flow and Position.
5	Develop a PLC ladder logic program for a two-way traffic light control.
INDUSTRIALPROCESS AUTOMATION	
6	Develop and implement PLC ladder logic program to automate the bottle filling in a beverages industry.
7	Develop and implement PLC ladder logic program to automate the water level control in a distillery plant.
8	Develop a PLC ladder logic program to automate the rolling process by speed control of a DC drive with optical sensor placed in feedback path in a steel rolling mill.
9	Design and implement a PLC based automatic star-delta starter for an industrial drive.
10	Design and implement a PLC based DOL starter for an industrial motor.
INDUSTRIAL PROCESS CONTROL	
11	Mimic creation of the control flow in a process industry using SCADA.
ROBOTICS	
12	Robotics – sensor, actuator, communication and programming for control actions in a pick and place robot.

TOTAL PERIODS: 60

COURSE OUTCOMES		
Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Design and implement process automation using control valves and pneumatic/hydraulic actuators.	4
2	Design and implement process automation using PLCs with electrical /pneumatic actuators.	4
3	Interface PLCs with HMI systems for control.	4
4	Network PLCs with field devices and supervisory control systems.	4
5	Develop programs for robotics given an industrial use case.	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3	3	3		1	3	3		3	3	
2	3	3	3	3	3	3		1	3	3		3	3	
3	3	3	3	3	3	3		1	3	3		3	3	
4	3	3	3	3	3	3		1	3	3		3	3	
5	3	3	3	3	3	3		1	3	3		3	3	

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

LABORATORY REQUIREMENTS FOR A BATCH OF 30 STUDENTS		
SL.NO	**DESCRIPTION OF EQUIPMENTS**	**QUANTITY REQUIRED**
1.	Pneumatic trainer kit	2
2.	PLC based pneumatic trainer kit	2
3.	PLC based hydraulics trainer kit	2
4.	PLC trainer kit	4
5.	PCs for interconnection with PLCs and for simulation	7
6.	Automation Studio software	5 user licenses
7.	PcVue SCADA software	250 tags
8.	Siemens TIA Portal v17	5 user licenses
9.	PLC application modules	2 sets
10.	HMI trainer	2 sets
11.	DC drive for PLC control	1
12.	Transducers	1
13.	Trainer kit for signal conditioning	1
14.	Star delta starter for induction motor with PLC control	2
15.	DOL Starter for induction motor with PLC control	2
16.	Robotics trainer	1

EE22612	POWER SYSTEM LABORATORY	L T P C
		0 0 3 1.5

COURSE OBJECTIVES

- Develop models of power system networks and analyze various methods of steady state load flow solution.
- Perform transient and small signal stability analysis for various faults in power systems using different methods.
- Develop load frequency control model for single area and two-area systems and perform static and dynamic analysis for various cases.
- Understand power system unit commitment and economic dispatch problem and solution methodologies.

LIST OF EXPERIMENTS

Modeling and Analysis of Transmission Lines	
1.	Computation of Transmission Line Parameters
2.	Modeling of Transmission lines
3.	Performance analysis of transmission lines
Steady State Modeling and Analysis of Power System Network	
4.	Formation of Bus Admittance and Impedance Matrices
5.	Power Flow Analysis
6.	Symmetrical and Unsymmetrical Fault Analysis
Transient Analysis of Power System	
7.	Transient and Small Signal Stability Analysis of SMIB system
8.	Electromagnetic Transients in Power Systems – Simulation using PSCAD/ETAP
Plant Level Control of Power System	
9.	Load – Frequency Control of Conventional Power Systems with/without WECS
10.	Design and Stability Analysis of Automatic Voltage Regulator
Economic Operation of Power System	
11.	Unit Commitment and Economic Load Dispatch
12.	Weighted Least Square (WLS) State Estimation

TOTAL PERIODS:45

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Model the transmission lines, power network and obtain the solution for steady state power flow problem.	4
2	Compute the short circuit capacity of power system and examine the stability conditions for various faults.	5
3	Design and analyze a load frequency controller of the power system.	4
4	Formulate and solve Unit commitment and Economic dispatch problem.	5
5	Analyze the electromagnetic transient phenomenon in power systems caused due to switching and faults.	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3	3		2		1	1	1	2	1	3
2	3	3	3	3	3	2			1	1	1	2	1	3
3	3	3	3	3	3		2		1	1	1	2	1	3
4	3	3	3	3	3		2		1	1	1	2	1	3
5	3	3	3	3	3	2			1	1	1	2	1	3
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														

LABORATORY REQUIREMENTS FOR A BATCH OF 30 STUDENTS		
SL.NO	**DESCRIPTION OF EQUIPMENTS**	**QUANTITY REQUIRED**
1.	Personal Computers (Intel Core i5 or i7, 500 GB, 8 GB RAM)	30
2.	Printer HP Laser Jet 1020 Plus	2
3.	Server (Intel Core i7, 2 TB, 8 GB RAM or higher) (High Speed Processor)	1
4.	Software: EMTP / ETAP / MIPOWER any Power system simulation software	5
5.	Compilers: C / C++ / MATLAB	30

SEMESTER VII

EE22701	PROTECTION AND SWITCHGEAR	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To realize the causes of abnormal operating conditions of the power system apparatus.
- To understand the operating characteristics and functions of relays.
- To impart knowledge on apparatus protection and circuit breakers
- To introduce static and numerical relays

UNIT I	PROTECTION SCHEMES	9

Principles and need for protective schemes – Nature and causes of faults – Fault statistics - Types of faults and abnormal operating conditions – Types of protection - Primary and back up protection – Zones of protection and essential qualities of protection – Methods of Neutral grounding – Microgrid and distributed generation protection - IEEE standards.

UNIT II	ELECTROMAGNETIC RELAYS	9

Types and operating principles of relays – Recent developments – Desirable Qualities and Terms of Protective Relaying – Universal torque equation – R-X diagram – Electromagnetic Relays – Over current, Directional, Distance, differential, Negative sequence and Under frequency relays.

UNIT III	APPARATUS PROTECTION	9

Current transformers and Potential transformers and their applications in protection schemes - Protection of transformer, generator, motor, busbar and transmission lines.

UNIT IV	STATIC RELAYS AND NUMERICAL PROTECTION	9

Static relays – Phase, Amplitude Comparators – Duality of comparators – Synthesis of various relays using Static comparators – Numerical relays - Block diagram – Overcurrent protection, transformer differential protection and distance protection of transmission lines – Microcontroller based overcurrent protection – Introduction to adaptive relays.

UNIT V	CIRCUIT BREAKERS	9

Arc Interruption - Theories and methods – DC and AC circuit breaking – re-striking voltage and recovery voltage - rate of rise of restriking voltage - current chopping - interruption of capacitive currents - resistance switching - Types of circuit breakers – Air, Oil, SF6 and vacuum circuit breakers – Rating and selection of Circuit breakers.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Badri Ram, B.H.Vishwakarma, 'Power System Protection and Switchgear', Tata McGraw Hill Education Pvt. Ltd., 2011, 2nd Edition.
2.	B.Rabindranath and N.Chander, 'Power System Protection and Switchgear', New Age International Publishers, 2011, 1st Edition.
3.	M.L.Soni, P.V.Gupta, U.S.Bhatnagar, A.Chakrabarti, 'A Text Book on Power System Engineering', Dhanpat Rai & Co., 2016.

REFERENCE BOOKS

1.	Sunil S.Rao, 'Switchgear and Protection', Khanna Publishers, New Delhi, 2008.
2.	Y.G.Paithankar and S.R.Bhide, 'Fundamentals of power system protection', Prentice Hall of India Pvt. Ltd., New Delhi, 2010, 2nd Edition.
3.	C.L.Wadhwa, 'Electrical Power Systems', New Age International (P) Ltd., 2010, 6th Edition.

4.	Ravindra P.Singh, ' Switchgear and Power System Protection', PHI Learning Private Ltd., New Delhi, 2009.
5.	Bhavesh Bhalja, R.P. Maheshwari, Nilesh G. Chotani,'Protection and Switchgear' Oxford University Press, 2011.
6.	C37 series of IEEE standards for power system protection.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Interpret the faults in power system and essential qualities of protection.	2
2	Understand the operation of various electromagnetic relays.	2
3	Analyze the protection schemes for power system apparatus.	4
4	Synthesize various relays using static comparators and microcontroller.	4
5	Analyze the circuit breaker arcing phenomenon and understand the functioning of various types of circuit breakers.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3								3		3
2	3	3	3	3								3	3	3
3	3	3	3	3								3	2	3
4	3	3	3	3								3	3	3
5	3	3	3	3								3		3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22708	SMART GRID: THEORY AND PRACTICES	L T P C
		3 02 4

COURSE OBJECTIVES

- Inculcate the concept of smart grid technology, its significance and global initiatives.
- Familiarize the smart grid transmission & distribution technologies emphasizing on the advanced metering infrastructures.
- Expertise the high performance computing and networking standards for smart grid applications.

UNIT I	INTRODUCTION TO SMART GRID	9+6

Evolution of Electric Grid - Conventional vs smart Grid - Environmental impact and Climate Change - Economic Issues - Smart grid: opportunities, challenges and benefits - National and International Initiatives - Introduction to Distributed Generation - Microgrids - Storage Technologies - Electric Vehicles: Grid to Vehicle and Vehicle to Grid charging concepts.

Experiments:

1. Design and simulation of Microgrid.
2. Forecasting of wind and solar energy for techno-economic analysis.

UNIT II	SMART GRID TECHNOLOGIES – TRANSMISSION SYSTEM	9+6

Transmission systems: FACTS and HVDC - Energy Management System: Data sources (SCADA, IED) - Phase Measurement Unit (PMU) - EMS Applications: Unit Commitment, Automatic Generation Control (AGC) - security assessment and control - Wide Area Monitoring Protection and Control (WAMPAC) - Smart integration of distributed energy resources.

Experiments:

1. Design of virtual PMU and optimal placement for proper monitoring.
2. Design and simulation of Smart grid.

UNIT III	SMART GRID TECHNOLOGIES – DISTRIBUTION SYSTEM	9+6

Distribution Automation: Modern smart substation, Substation automation equipment: SCADA, IED, Bay controller, RTU - Fault location - isolation and restoration in non-automated, partially automated and fully automated distribution network - Distributed Management System: structure and main components (overview) – CIS - Automation of DMS – Applications: System monitoring, Integration of Micro Grids and Outage Management System (OMS).

Experiments:

1. Protection design of conventional ring-main power system.
2. Relay coordination in smart grid protection scheme.

UNIT IV	SMART METERS AND ADVANCED METERING INFRASTRUCTURE	9+6

Evolution of electricity metering (Accumulation meters, AMR, Smart Meters, AMI) - Conventional meter v s Smart meter- Smart meters: Hardware, Communication Protocols - Advanced Metering Infrastructure (AMI): drivers and benefits, protocols, standards and initiatives, Application: Demand-side integration: Services, Implementation (price and incentive based) and hardware required.

Experiments:

1. Design of smart meters and Advanced Metering Infrastructure.
2. Develop Demand response programs for distribution system.

UNIT V	HIGH PERFORMANCE COMPUTING	9+6

Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN),Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter,

Types of cyber-attacks in smart grid, Prevention of cyber-attacks by means of cyber security in smart grids.

Experiments:

1. Cyber security coding for smart grid communications.
2. DC state estimation in Network protocol and Attack Detection.

TOTAL HOURS: 75

TEXT BOOKS

1.	Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley and Sons Ltd., February 2012.
2.	Stuart Borlase, 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.

REFERENCE BOOKS

1.	G. Masters, 'Renewable and Efficient Electric Power System', Wiley–IEEE Press, 2013, 2nd Edition.
2.	Vehbi C. Gungor, DilanSahin, TaskinKocak, Salih Ergut, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, 'Smart Grid Technologies: Communication Technologies and Standards IEEE Transactions on Industrial Informatics', Vol. 7, No. 4, November 2011.
3.	James Momoh, Smart Grid Fundamentals of Design and Analysis‖, IEEE Press, 2012.
4.	Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang "Smart Grid – The New and Improved Power Grid: A Survey", IEEE Transaction on Smart Grids.
5.	Tony Flick, Justin morehouse, Securing the smart grid: Next generation power grid security, Elsevier, 2010.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Analyze challenges and benefits of smart grids and its present developments.	4
2	Analyze the smart grid technologies in Transmission systems	4
3	Assess the role of automation and digitization in Distribution systems	4
4	Analyze the advanced metering infrastructure and hardware implementation.	4
5	Identify communication networks andcyberattack prevention for smart grid.	4

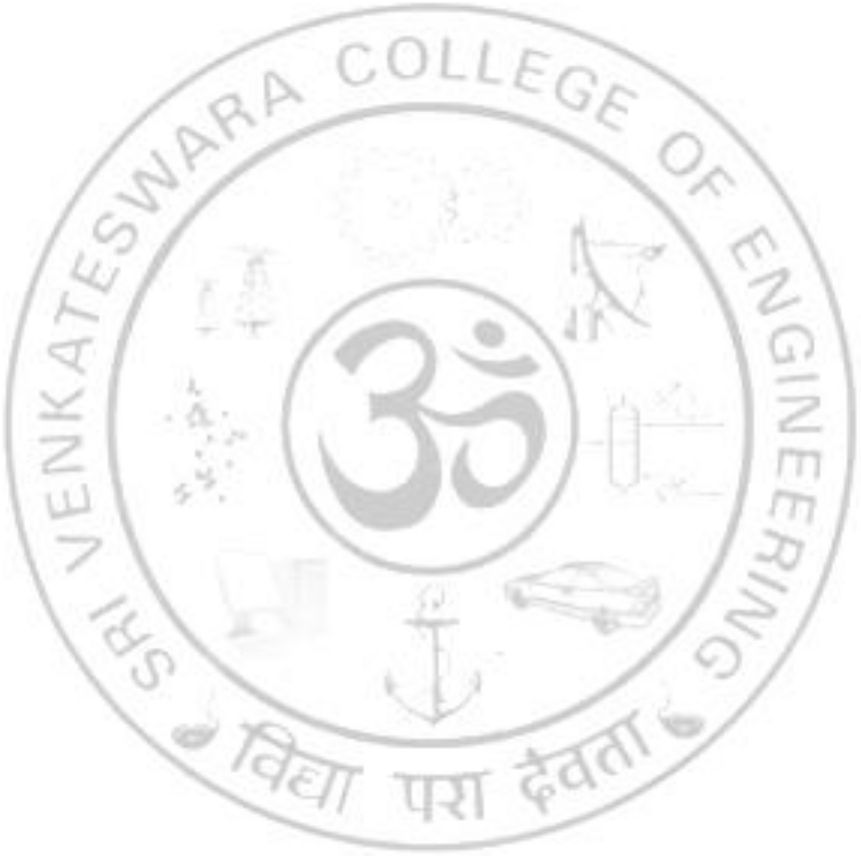
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3			2	3	3	2		2	2				3
2	3	2	3	3	3	3	2		2	2				3
3	3	2	3	3	3	3	2		2	2				3
4	3	2	3	3	3	3	3		2	2			3	3
5	3		2	3	3	3			2	2				3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

LABORATORY REQUIREMENTS FOR A BATCH OF 30 STUDENTS		
SL.NO	**DESCRIPTION OF EQUIPMENTS**	**QUANTITY REQUIRED**
1.	Personal computer with MATLAB	30



EE22709	ELECTRIC VEHICLES: THEORY AND PRACTICES	L T P C
		3 0 2 4

COURSE OBJECTIVES

- To introduce the vehicle dynamics and architecture of electric vehicles.
- To learn the motors used for Electric Vehicle applications.
- To understand Energy storage technologies used in Electric Vehicles.
- To realize design of electric vehicle, drive train and subsystems.
- To learn the battery charging and energy management strategies.

UNIT I	VEHICLE ARCHITECTURE AND MODELLING	9 + 6

Fundamentals of Vehicle Dynamics – Vehicle operating modes – Overview of IC Engine Vehicle – Fuel efficient operating zones – Hybrid Electric Vehicle: Architecture, drive-train topologies and power flow control – Electric Vehicle: Architecture, drive-train topologies and power flow control – EV performance parameters (range, acceleration and maximum speed) – Standard Drive Cycles.

Experiments:

1. Modeling the acceleration of electric vehicle
2. Simulation of GM-EV1 vehicle acceleration

UNIT II	ELECTRIC PROPULSION SYSTEM	9 + 6

eMobility requirements – suitable motors – Overview on construction and working of EV motors – Modeling and multi-quadrant control of DC Motor drives, Induction Motor drives, Permanent Magnet Synchronous Motor drives, Switched Reluctance Motor drives – Comparison of speed torque characteristics of IC engine and Electric drives – selection of motors and gears for fuel efficient operating zones.

Experiments:

1. Modeling and Simulation of DC motor control
2. Load test on BLDC Hub Motor of Electric Vehicle Two-wheeler

UNIT III	ENERGY STORAGE SYSTEM	9 + 6

Energy and power requirement of vehicles – sizing of energy storage system (ESS) – ESS for EVs: Battery, Super capacitors, Fuel cell, Flywheel, Hydrogen Energy Storage – Comparison – Ragone plot – Hybridization of ESS: Need and different topologies – Battery conditions & Specifications – Range prediction methods: constant current discharge, power density approach.

Experiments:

1. Range Simulation of an Electric Vehicle
2. Design and implementation of power electronic converter and control for hybridization of energy storage in EV

UNIT IV	DRIVE SYSTEM SIZING	9 + 6

Sizing the drive system: Design requirement specifications, Tractive effort calculation – Sizing the propulsion motor, Matching the electric machine and the internal combustion engine (ICE) – Operating zones – Selecting type & size of the energy storage system – Design of the power electronic control system – Selecting communication protocols and design of supporting subsystems.

Experiments:

1. Sizing of series, parallel hybrid electric drive train – Case Study
2. Study and implementation of CAN for EV application

UNIT V	BATTERY CHARGING AND MANAGEMENT STRATEGIES	9 + 6
Battery module and pack design – Battery management system (BMS) Hardware and Software: Cell balancing, SoC measurement, Thermal management – Different Charging Methods (Regular, Fast, Opportunity) – Charging Algorithms: CCCV, Multistage charging, Pulse charging – Charging termination –Charger protocols, OCPP, V2G, CHADEMO, Bharat charger – Standards used for chargers – Application of IoT to charging infrastructure. **Experiments:** 1. Design and simulation of a DC charger circuit. 2. Design and implementation of a BMS.		
		TOTAL PERIODS: 75
TEXT BOOKS		
1.	Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, 'Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2018, 3rdEdition.	
2.	Iqbal Hussein, 'Electric and Hybrid Vehicles: Design Fundamentals', CRC Press, 2021, 3rd Edition.	
REFERENCE BOOKS		
1	John M Miller, 'Propulsion Systems for Hybrid Vehicles', Institution of Engineering and Technolog, 2010, 2ndEdition.	
2	C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001.	
3	James Larminie, John Lowry, 'Electric Vehicle Technology Explained', Wiley, 2012, 2ndEdition.	
4	Sheldon S. Williamson, 'Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles', Springer, 2013.	
5	Chris Mi, M. Abulm Masrur, David WenzhongGao, 'Hybrid Electric Vehicles Principles and Applications with Practical Perspectives', Wiley Publication, 2011.	

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Identify and emulate the suitable drive-train topology of an electric vehicle for the designated application.	4
2	Analyze the selection aspects of various propulsion units used for electric vehicle application.	4
3	Develop practical skills to assess and optimize vehicle range under varying conditions.	4
4	Analyze and optimize the sizing of drive systems of Electric and Hybrid vehicles.	4
5	Analyze and apply charging technologies, algorithms, and battery management systems for efficient electric vehicle operation with optimized battery performance.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	3	2	2	2	3				2	2		2	3	
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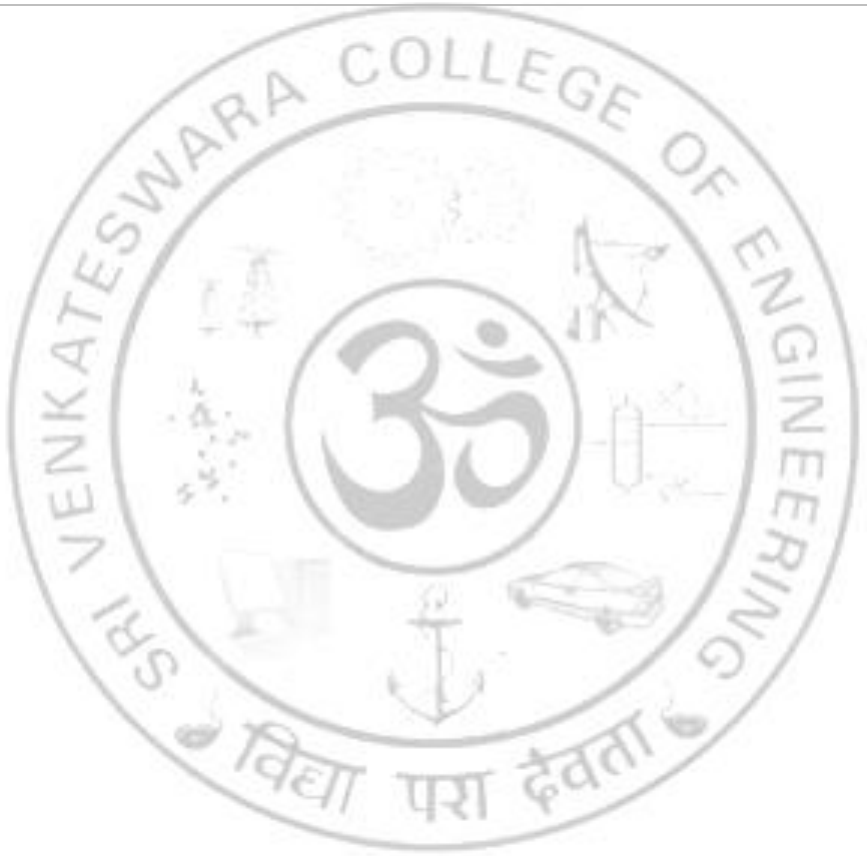
3	3	3	3	3	3	2	2		2	2		3	3	2
4	3	3	3	3	3	2	2		2	2		3	3	2
5	3	3	3	2	3	2	2		2	2		3	3	2
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														



EE22711	MINI PROJECT	L T P C
		0 0 4 2

COURSE OBJECTIVES

- The main objective of this course is the culmination of the knowledge gathered in the field of Electrical and Electronics Engineering through its application to the diagnosis and solution of the real-world problems which can be executed as a mini project.

GUIDELINES

Expectations and Assessment

- Mini Project involves modeling, simulation, analysis and implementation by utilizing the technical knowledge acquired and it entails the application of fundamental principles to develop a product of utility. The mini project may be a prelude to EE22811 Project work with the simulation part completed or it can be an exclusive mini project. The progress is assessed through three internal reviews and an end semester examination with the submission of project report.

General

- A problem can be identified in one of the thrust areas of Electrical & Electronics Engineering through in-depth survey and critical study of published literature.
- The project work can be carried out as an individual work or a group project with maximum three students in it with an identified supervisor who is an expert in the domain from among the faculty of the department assigned as mentor of the team.
- The identified problem can be segmented into modules to encourage individual contribution.
- Students are expected to model/formulate the problem, design appropriate solution methodology, test in the suitable simulation tool and analyze the results or a develop a product of utility by the application of principles learned and the practical skills acquired.

TOTAL PERIODS: 60

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Identify and formulate the problem and perform literature search in the area of interest.	4
2	Evolve the methodology to execute the project through its various phases.	4
3	Conduct experiments/ Design and analysis/ Solution iterations as per the requirements.	5
4	Work in multi- disciplinary areas and provide solutions to the identified problems.	5
5	Compile the findings and conclude with written report and oral presentation and to formulate solutions with the implementation of new technologies.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3	3				3	3		3	3	3
2	3	3	3	3	3				3	3	3	3	3	3
3	3	3	3	3	3				3	3	3	3	3	3
4	3	3	3	3	3	3	3		3	3		3	3	3
5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22712	INDUSTRIAL TRAINING/INTERNSHIP	LT P C
		0 0 0 2

COURSE OBJECTIVES

- Enter the realm of practical innovation, where theoretical knowledge intersects with experiential learning. This empowers students to tackle real-world challenges directly, harnessing state-of-the-art technologies to engineer impactful solutions.

PREREQUISITE

- Provide students with a robust preliminary foundation in Electrical and Electronics Engineering tailored to meet the current and future demands of the industrial sector.

GUIDELINES:

Expectations and Assessment:

- The Industrial Internship program entails hands-on experience with real-time prototype models, conducting simulation studies, and evaluating solutions in Electrical and Electronics Engineering through exposure to industrial practices. Students are required to complete their Internship/Training before the 6th semester and must accrue a minimum of 1 credit (equivalent to 2 weeks) or a maximum of 2 credits (equivalent to 4 weeks).

TOTAL:04 WEEKS

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Unearth and redefine problems, applying creativity to craft innovative design solutions.	4
2	Develop strategic methodologies to guide the projects through various phases, igniting progress with each step.	4
3	Engineer circuits and systems, selecting components with precision to meet the demands of real-world applications.	4
4	Utilize simulation tools and algorithms to illuminate pathways to solutions and refine the understanding.	4
5	Communicate the findings effectively through compelling written reports and captivating oral presentations, showcasing the journey of growth and learning during the internship program.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	2	2	2	2	3	3	3	3	3	3	3
2	3	3	3	2	2	2	2	3	3	3	3	3	3	3
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4	3	3	3	2	2	2	2	3	3	3	3	3	3	3
5	3	3	3	2	2	2	2	3	3	3	3	3	3	3
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														

SEMESTER VIII

EE22811	PROJECT WORK	L T P C
		0 0 16 8

COURSE OBJECTIVE

- The main objective of the project work is the culmination of the knowledge gathered in the field of Electrical and Electronics Engineering through its application to the diagnosis of the real-world problems and to formulate solutions with the implementation of new technologies.

GUIDELINES

- The Program Consultative Committee (PCC) can recommend the students to carry out their final semester project work for six months in industry/research organizations provided that they should not have any standing arrears and underwent their eighth semester courses during the sixth and seventh semesters. The Project work can be internship to be carried out in industry as part of job offer obligation or it can be extension of Mini Project carried out in the previous semester or It can be an exclusive industry project or inhouse project.

Industry Projects

- A team is also encouraged to carry out the project work in industry that can inculcate in them the spirit of research and development and technical leadership while working with practical real time problems.
- The supervisor from industry reviews and finalizes the approach to solve the identified problem through field investigation.
- A permission letter, student periodical attendance report and project completion certificate provided by the industry are to be submitted to faculty supervisor in the department.

Expectations

- Project work is the validation of simulation through the design, development and implementation of the prototype or it can be an independent industry project or inhouse project or an internship carried out in the placed industry.
- The software-based project work has to be validated through application development/practical system.

Assessment

- Assessment involves three reviews to ensure the project progress and an end semester examination with the Project work report submission.
- Students are highly encouraged to publish their outcome in peer reviewed conferences, journals and to apply for patent to enrich the research milieu of the department
- The findings of the project work have to be analyzed, consolidated and can be presented as a final product.

TOTAL PERIODS: 240

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Identification and formulation of the problem through literature search in the area of interest and / or Conduct feasibility study, market analysis and design standardization for project implementation.	4
2	Perform Design/Analysis and Simulation/Solution iterations as per the requirements and Selection of suitable hardware and assemble /identify and extend software solution for real-time problem.	5
3	Develop a device/prototype/solution, test and characterize.	5
4	Validate the prototype/real time problem solution/characterization through performance analysis under different system conditions.	5
5	Analyze the findings, propose the suitable solution and document the results as a technical report for oral presentation.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3	3				3	3		3	3	3
2	3	3	3	3	3				3	3	3	3	3	3
3	3	3	3	3	3				3	3	3	3	3	3
4	3	3	3	3	3	3	3		3	3		3	3	3
5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

VERTICALII: POWER SYSTEM ENGINEERING

EE22021	RESTRUCTURED POWER SYSTEMS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To impart knowledge on various types of deregulated markets in power systems.
- To analyze the technical and non-technical problems and possible solutions in the deregulated power industry.
- To familiarize different market mechanisms and summarize the role of various entities in the market.
- To analyze the energy and ancillary services management in the deregulated power industry.
- To understand the restructuring framework in power sector.

UNIT I	INTRODUCTION TO RESTRUCTURING OF POWER INDUSTRY	9

Reasons for restructuring - Understanding the restructuring process - Operating Experiences of Deregulated Electricity Markets in various Countries - Consumer behaviour - Supplier behaviour – Market equilibrium - Short-run and Long-run costs - Various costs of production - Market models based on contractual arrangements - Market architecture.

UNIT II	TRANSMISSION CONGESTION MANAGEMENT	9

Definition, reasons, importance, and features of congestion management. - Classification of congestion management methods - Calculation of ATC - Non-market methods - Market based methods - Nodal pricing - Inter-zonal Intra-zonal congestion management - Price area congestion management - Capacity alleviation method.

UNIT III	LOCATIONAL MARGINAL PRICES (LMP) AND FINANCIALTRANSMISSION RIGHTS	9

Mathematical preliminaries - Fundamentals of locational marginal pricing - Lossless DCOPF model for LMP calculation - Loss compensated DCOPF model for LMP calculation - ACOPF model for LMP calculation - Risk Hedging Functionality of financial Transmission Rights - FTR issuance process - Treatment of revenue shortfall - Secondary trading of FTRs - Flow Gate rights - FTR and market power – FTR and merchant transmission investment.

UNIT IV	ANCILLARY SERVICE MANAGEMENT AND PRICING OF TRANSMISSION NETWORK	9

Introduction - Types of ancillary services - Load-generation balancing related services - Voltage control and reactive power support services - Black start capability service - Mandatory provision of ancillary services - Markets for ancillary services - Co-optimization of energy and reserve services - International comparison. Pricing of transmission network: Power wheeling - principles of transmission pricing - transmission pricing methods - Marginal transmission pricing paradigm - Composite pricing paradigm - loss allocation methods.

UNIT V	MARKET EVOLUTION	9

International markets - US markets - ERCOT market - Standard Market Design (SMD) - PJM market - Nordic power market -Comparison of power markets- Reforms in Indian power sector – Framework of Indian power sector - Reform initiatives - Availability Based Tariff (ABT) - Electricity Act 2003 - Open Access issues - Power exchange.

TOTAL HOURS: 45

TEXT BOOKS

1	Kankar Bhattacharya Maath H.J. Bollen and JaapE.Daalder, 'Operation of restructured power systems', Kluwer academic publishers, USA, 2012.
2	Daniel Kirschen and GoranStrbac,'Fundamentals of Power System Economics', John Wiley

	and Sons Ltd, 2004.
REFERENCE BOOKS	
1	Sally Hunt, 'Making competition work in electricity', John Wiley and Sons, Inc., 2002.
2	Dr. A.R. Abhyankar, Prof. S.A. Khaparde, 'Web course on Restructured Power Systems', IIT Delhi,IIT Bombay, under http://nptel.iitm.ac.in
3	LoiLeiLai, 'Power system Restructuring and regulation: Trading, Performance and Information Technology', John Wiley sons, 2001.
4	P.Venkatesh, B.V.Manikandan, S.Charles Raja and A.Srinivasan, 'Electrical power systems analysis', Security and Deregulation, PHI 2012.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Familiarize the process of restructuring of power industry and analyze the philosophy of market models	4
2	Analyze various methods of congestion management in deregulated power system	4
3	Analyze the locational marginal pricing and financial transmission rights	4
4	Analyze the ancillary service management and wheeling charges	4
5	Elucidate the evolution of Indian and US power markets	5

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	2		3	3	1	2	1	2	1		3
2	3	3	3	3		3	3	1	2	1	2	1		3
3	3	3	3	3		3	3	1	2	1	2	1		3
4	3	3	3	3		3	3	1	2	1	2	1		3
5	3	3	3	3		3	3	1	2	1	2	1		3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22022	SUBSTATIONAUTOMATION	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To familiarize with the components and functions of substation automation systems (SASs).
- To understand the interfacing arrangements between substation and automation.
- To acquaint knowledge on substation and automation integration, communication protocols and security.
- To know the standards of IEC 61850 Communication Networks and Systems in Substations
- To learn the structured/unstructured tests on SAS components.

UNIT I	INTRODUCTION	9

Evolution of Substation Automation Systems (SASs) - Functions of SASs - IEC 61850 substation architecture- Process Level - Primary equipment - Bay Level Components, Bay Controller (BC) - Process Bus - Station Level - Station Controller - Human Machine Interface HMI - Protocol Conversion Task - Station Bus.

UNIT II	INTERFACE BETWEEN AUTOMATION AND THE SUBSTATION	9

Physical Challenges – Measurements- SA system electrical measuring interface, Measurement sensor placement, Characteristics of Digitized Measurements, Measuring Devices, Scaling Measured Values, Pulse Accumulators - State (Status) Monitoring - Control Functions - Communication Networksinside the Substation.

UNIT III	SUBSTATION INTEGRATION AND AUTOMATION	9

Introduction - Open Systems - Operational versus Nonoperational Data - Data Flow - Asset Management - Redundancy - System Integration Issues - System Components - Cyber Security - OSI Communications Model - Protocol Fundamentals - Synchrophasors

UNIT IV	COMMUNICATION NETWORKS	9

IEC 61850 for interoperability in substations - lnteroperability and opensystems - IEC 61850 as system standard for substations - Structure - Communication approach - Model approach - Engineering approach - Seamless Communicationfor Utilities - Benefits.

UNIT V	TESTS ON SAS COMPONENTS	9

Type Tests - Acceptance Tests - Tests for Checking the Compliance with the Standard IEC 61850 - Factory Acceptance Tests: Test Arrangement - System Simulator - Hardware Description - Software Identification - Test Instruments - Documentation to be Available - Checking System Features - Planned Testing Program for FAT – Non structured FATs – SAS: Future Technological Trends.

TOTAL PERIODS: 45

TEXT BOOKS

1.	John D.McDonald, 'Electrical Power Substation Engineering', CRC Press, 2017, 3rd Edition.
2.	DahiyaR.S, 'Sub-Station Engineering, Design, Concepts and Computer Application', S.K. Kataria and Sons, Reprint 2022.

REFERENCE BOOKS

1.	Evelio Padilla, "SubstationAutomation Systems: Design and Implementation", John Wiley and Sons Ltd, 2016, 1st Edition.
2.	Satnam,P.S, Gupta, P.V., 'Substation Design and Equipment', Dhanapat Rai Publications, 1st Edition, 2013.
3.	'Network Protection and Automation Guide', Published by Alstom Grid, 2011, 2nd Edition.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Demonstrate the functions of various levels in substation automation systems	3
2	Illustrate the measurements and interfacing between substation and automation system	3
3	Explore the substation integration system components and technical issues	3
4	Apply the substation communication standards and security	3
5	Describe the different testing procedure of SAS components	3
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	2	3	2	1	2	1		1	2	2	2	3
2	3	2	2	3	2	1	2	1		1	2	2	2	3
3	3	2	2	3	2	1	2	1		1	2	2	2	3
4	3	2	2	3	2	1	2	1		1	2	2	2	3
5	3	2	2	3	2	1	2	1		1	2	2	2	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22023	HVDC AND FACTS	L T P C
		3 0 0 3

COURSE OBJECTIVES

To impart knowledge on

- AC transmission systems and DC transmission systems
- Basic operation and control of variable impedance type FACTS Controllers
- Operation and control of VSC based FACTS controllers
- Basic operation of Line Commutated Converter(LCC) based HVDC links
- Features of voltage source converter based HVDC control

UNIT I	INTRODUCTION	9

Reactive power control in electrical power transmission lines - Load & System compensation - Uncompensated transmission line - Shunt and Series compensation - Need for HVDC Transmission - Comparison between AC and DC Transmission - Types of HVDC transmission System.

UNIT II	FACTS CONTROLLERS	9

Concept of FACTS – Compensation of transmission systems - Types of FACTS controllers - Static shunt compensators - SVC - Static series compensators - GCSC,TSSC,TCSC, TCPAR - Static and dynamic performance improvement with FACTS controllers – Applications.

UNIT III	VOLTAGE SOURCE CONVERTER BASED FACTS	9

Basic operating principles and control approaches of STATCOM, SSSC, UPFC and IPFC - Applications - Enhancement in Power transfer capability and transient stability - Prevention of voltage instability.

UNIT IV	HVDC TRASMISSION	9

Evolution - Basic concept of HVDC transmission - Operation of Graetz bridge - Effect of delay in Firing Angle – Effect of commutation overlap - Equivalent circuit - Model of operations and control of power flow - CC and CIA mode of operation.

UNIT V	HVDC SYSTEM CONTROL	9

HVDC system control feature – Control modes – Control schemes and Control comparison- Starting and stopping of HVDC link - Mechanism of active and reactive power flow control - Harmonics & filters - Faults and abnormal operation and protection - Topologies of MTDC system.

TOTAL HOURS: 45

TEXT BOOKS

1	Narain G Hingorani, LaszioGyugyl, ‘Understanding FACTS Concepts and Technology of Flexible AC Transmission System’, IEEE press and John Wiley and Sons, 2000.
2	K.R.Padiyar, ‘HVDC Power Transmission Systems’, New Age International (P)Ltd., NewDelhi, 2017, 3rd Edition,.

REFERENCE BOOKS

1	Mohan Mathur, R., Rajiv. K. Varma, ‘Thyristor – Based Facts Controllers for Electrical Transmission Systems’, IEEE press and John Wiley and Sons, 2002.
2	K.R.Padiyar, ‘FACTS Controllers in Power Transmission and Distribution’, New Age International(P) Ltd., Publishers, New Delhi,2016, 2nd Edition,.
3	Vijay K.Sood, ‘HVDC and FACTS controllers – Applications of Static Converters in Power System’,Springer-Verlag New York Inc, 2004.
4	A.T.John, ‘Flexible AC Transmission System’, Institution of Engineering and Technology, 1999.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Identify the problems in AC transmission systems and understand the need for FACTS and HVDC Transmission	2
2	Analyze the basic operation and control of FACTS and its applications	4
3	Analyze basic operation and control of voltage source converterbased FACTS controllers	4
4	Demonstrate basic operation and control of Line Commutated HVDC Transmission	3
5	Explain the VSC based HVDC Transmission control	3
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	3	1					1		2	3	3
2	3	3	2	2	2					1		2	3	3
3	3	3	2	3	2					1		2	3	3
4	3	3	2	2	2					1		2	3	3
5	3	3	2	3	2					1		2	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22024	POWER SYSTEM DYNAMICS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To impart knowledge on mathematical modelling of a synchronous machine in detail.
- To develop the mathematical model for excitation and speed governing systems
- To enhance the knowledge on transient stability concepts in power systems.
- To analyze dynamic and voltage stability behavior of power systems

UNIT I	SYNCHRONOUS MACHINE MODELLING	9

Conceptual importance of power system transient and dynamic stability in the operation and design - Basic equations of a synchronous machine: stator circuit equations, stator self, mutual and stator to rotor mutual inductances - dq0 Transformation: flux linkage and voltage equations for stator and rotor in dq0 coordinates, electrical power and torque, physical interpretation of dq0 transformation - Equivalent circuits - steady state analysis - Synchronous machine representation in power system studies.

UNIT II	MODELLING OF EXCITATION SYSTEM	9

Excitation system requirements - Basic concepts and definitions of exciter and voltage regulators - Elements, types, control and protective functions of excitation system - Modelling of excitation system components: Modelling of IEEE type 1 excitation system - Saturation function - Stabilizing circuit.

UNIT III	MODELLING OF SPEED GOVERNORS	9

Function of speed governing systems - Block diagram and state space representation of IEEE mechanical hydraulic and electrical hydraulic governors for hydro and steam turbines - Block diagram of governor with transient droop compensation - Modelling of single reheat tandem compounded type steam turbine – Generic speed-governing system model.

UNIT IV	TRANSIENT STABILITY ANALYSIS	9

Review of numerical integration methods: Euler and fourth order Runge - Kutta methods - Modeling of multi machine power system with one axis machine model – Inclusion of excitation system and speed governing system - Power system stabilizer- Assumptions made in stability studies- Transient stability analysis simulation using R-K method of fourth order (Gill's technique).

UNIT V	DYNAMIC AND VOLTAGE STABILITY ANALYSIS	9

System response to small disturbances – Simplified linear model of synchronous machine - Effect of excitation on dynamic stability - Approximate system representation - Supplementary stabilizing signals. Classification of voltage stability - Basic concepts related to voltage stability: Generator, transmission system and load characteristics - Factors affecting voltage stability - Voltage collapse - Prevention of voltage collapse.

TOTAL PERIODS: 45

TEXT BOOKS

1.	R.Ramanujam, 'Power System Dynamics: Analysis and Simulation', Prentice Hall India, 2009.
2.	Prabha Kundur, 'Power System Stability and Control', McGraw Hill, USA 2006.

REFERENCE BOOKS

1.	M.A.Pai and W.Sauer, 'Power System Dynamics and Stability', Pearson Education Asia, India, 2002.
2.	P.M. Anderson and A.A.Fouad, 'Power System Control and Stability', GalgotiaPublications, New Delhi, 2003.

3.	J.Machowski, Bialek, Bumby, 'Power System Dynamics and Stability', John Wiley and sons, 2020,3rd edition.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Model the synchronous machines for stability analysis.	4
2	Develop dynamic model of excitation system.	4
3	Model the speed governing system for stability analysis.	4
4	Analyze stability condition synchronous machine for large disturbances.	4
5	Analyze dynamic and voltage stability conditions of power system.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	2	3	2	1		2	1		2		3
2	3	3	3	2	3	2	1		2	1		2		3
3	3	3	3	2	3	2	1		2	1		2		3
4	3	3	2	2	2	2	1		1	2		2		3
5	3	3	2	2	2	2	1		1	2		2		3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22025	HIGH VOLTAGE ENGINEERING	L T P C
		3 0 0 3

COURSE OBJECTIVES

To impart knowledge on

- Sources of transients like lightning, switching and temporary over voltages
- Various breakdown mechanisms in gaseous, liquid and solid dielectrics
- Generation of high AC/DC voltages and different techniques of measuring High voltages
- Different types of testing and insulation coordination
- Industrial applications of Electrostatic fields.

UNIT I	OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS	9

Importance of Electric Field Intensity in the Dielectrics - Causes of over voltages and its effects on power system — Lightning, switching surges and temporary over voltages – Reflection and Refraction of travelling waves - Theories of charge formation - Protection against overvoltage.

UNIT II	DIELECTRIC BREAKDOWN	9

Classification and properties of dielectrics - Gaseous breakdown in uniform and non-uniform fields – Corona discharges – Vacuum breakdown - Conduction and breakdown in liquid dielectrics - Breakdown in solid and composite dielectric - Application of insulating materials in electrical equipment.

UNIT III	GENERATION AND MEASUREMENTS OF HIGH VOLTAGES AND HIGH CURRENTS	9

Methods of generation of high AC voltage, Transformers in Cascade - Resonance Transformers - Generation of high DC voltage, Voltage multiplier circuits - Impulse voltage generator, single stage - Multistage impulse generator and triggering methods - Peak high voltage measurement techniques - Sphere gap - Electrostatic Voltmeters - Potential dividers - Types and applications - IS and IEC Standards.

UNIT IV	HIGH VOLTAGE TESTING AND INSULATION COORDINATION	9

Non-destructive high voltage testing and quality control on various power apparatus - Insulators – Bushings – Cables – Isolators and Circuit Breakers – Transformers – Surge arresters- Insulation Coordination- IS/IEC/IEEE standards and specifications.

UNIT V	ELECTROSTATIC APPLICATIONS IN INDUSTRY	9

Electrostatic applications- Electrostatic precipitation, separation, painting/coating, spraying, imaging, printing - Transport of materials – Manufacturing of sand paper – Smoke particle detector – Electrostatic spinning, pumping, propulsion – Ozone generation – Biomedical applications.

TOTAL PERIODS: 45

TEXT BOOKS

1. M S.Naidu and V. Kamaraju, 'High Voltage Engineering', Tata McGraw Hill, 2020, 6th Edition.
2. E. Kuffel and W.S. Zaengl, J.Kuffel, 'High voltage Engineering fundamentals', NewnesElsevier, New Delhi, 2005, 2nd Edition.

REFERENCE BOOKS

1. L.L. Alston, 'High Voltage Technology', Oxford University Press, 2011, 1st Indian Edition.
2. C.L. Wadhwa, 'High Voltage Engineering', New Age International Publishers, 2020, 4th Edition
3. Subir Ray, 'An Introduction to High Voltage Engineering' PHI Learning PrivateLimited, New Delhi, 2013, 2nd Edition.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Describe the causes and types of overvoltage	3
2	Explain various breakdown phenomena occurring in gaseous, liquid and solid dielectrics	3
3	Illustrate different methods of generating and measuring various high voltages and currents	3
4	Identify appropriate testing method(s) for various high voltage apparatus.	2
5	Suggest the suitable applications of high electric fields in day-to-day life problems	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	1	1		2	2		1	2		2	2	3
2	3	3	1	2		1	2		1	2		2	2	3
3	3	3	2	2		1	2		1	2	2	2	3	3
4	3	3	2	2		2	2		1	2	2	2	3	3
5	3	3	2	1		1	2		1	2		2	2	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22026	SOFT COMPUTING TECHNIQUES FOR POWER SYSTEMS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand emerging area of soft computing techniques.
- To learn the fundamentals of ANN and its application to electrical systems.
- To interpret the ideas of fuzzy sets, fuzzy logic and fuzzy inference system
- To gain knowledge on genetic algorithms while seeking global optimum in self-learning situations
- To provide in-depth knowledge on Hybrid Soft computing techniques and Swarm intelligence

UNIT I	SOFT COMPUTING TECHNIQUES IN POWER SYSTEMS	9

Introduction to Soft computing -Soft computing versus Hard computing - Types of Soft computing techniques - Basics of Fuzzy Systems - Artificial Neural Networks - Evolutionary Computing - Hybrid systems and its applications - Single and Multi - objective optimization.

UNIT II	ARTIFICIAL NEURAL NETWORKS	9

Neuron - Nerve structure and synapse - Artificial Neuron and its model-activation functions - Neural network architecture - Single layer and Multilayer feed forward networks - McCulloch Pitts neuron model- Perceptron model - Adaline and Madaline - Multilayer perception model - Back propagation learning algorithm - Application of ANN Models to Electrical Machine Modelling - Electrical Load Forecasting Problem - Load Frequency Controller.

UNIT III	FUZZY LOGIC SYSTEM	9

System's Modelling and Simulation Using Fuzzy Logic Approach - Selection of Variables, Range, Linguistic Values, Shape of Membership Functions, Fuzzy Union and intersection Operators- Defuzzification Method - Steady State and Transient Model of D.C. Machine - Fuzzy Control System - Power System Stabilizer Using Fuzzy Logic – Load Frequency Controller using Fuzzy Logic.

UNIT IV	BIO INSPIRED COMPUTING	9

Genetic algorithm: Basic Concepts - Working Principles – Encoding - Fitness Function - Reproduction - Inheritance Operators - Cross Over - Inversion and Deletion - Mutation Operator - Bit-wise Operators - Applications of Genetic Algorithms for voltage control, voltage stability, security assessment, feeder load balancing, AGC, Economic load dispatch, Unit commitment, Condition monitoring.

UNIT V	HYBRID SOFTCOMPUTING TECHNIQUES AND SWARM	9

Neuro Fuzzy Hybrid systems – Genetic Neuro Hybrid systems - Fuzzy Genetic Hybrid systems - Swarm Intelligence algorithm -Particle swarm optimization - Ant colony optimization -Artificial Bee Colony optimization - Applications.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Sivanandam S.N., Deepa S.N., 'Principles of Soft Computing', Wiley India Pvt. Ltd., 2018, 3rd Edition.
2.	S. Rajasekaran., G. A. Vijayalakshmi Pai., 'Neural Networks, Fuzzy Systems and evolutionary Algorithms: Synthesis and Applications', PHI Learning, 2017, 2nd Edition.

REFERENCE BOOKS

1.	Kosko B., 'Neural Networks and Fuzzy Systems', Prentice-Hall of India Pvt. Ltd., 1994.
2.	Timothy J. Ross, 'Fuzzy Logic with Engineering Applications' Wiley India, 2010, 3rd Edition.
3.	Goldberg D.E., 'Genetic algorithms in Search, Optimization and Machine learning', Addison

	Wesley, 1989.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Identify the soft computing techniques and their roles in building intelligent machines.	2
2	Analyze a given computational task to solve it through neural network	4
3	Design a fuzzy based soft computing system to address the engineering problems	4
4	Apply Genetic Algorithm operations and other bio-inspired algorithms for solving a computational task.	3
5	Design and implement a soft computing system for various power system applications.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3	3	2	2	1	1	2	2	2	3	3
2	3	3	3	3	3	2	2	1	1	2	2	2	3	3
3	3	3	3	3	3	2	2	1	1	2	2	2	3	3
4	3	3	3	3	3	2	2	1	1	2	2	2	3	3
5	3	3	3	3	3	2	2	1	1	2	2	2	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22027	POWER SYSTEM MANAGEMENT	L T P C
		30 0 3

COURSE OBJECTIVES

- Toidentifythe roles andresponsibilitiesofdifferent entitiesinthepower market
- Toeducatethedistributedsystemdesignbasedonforecasteddata
- To impart knowledge of power system planning
- To understand the electrical safety procedures and methods
- Todiscuss the need for energymanagement and energyconservation

UNIT I	DEREGULATION AND POWER MANAGEMENT	9

Introduction - Deregulation of electric utilities - Energy generation and transmission expansion in new environment - Pricing electricity in deregulated environment - Availability based tariff advances and its applications in online control of power system - Congestion management. Power scenario in India - Grid and Load management in power sector - Management of Electricity Demand Scenario in Tamil Nadu state and India.

UNIT II	LOAD CHARACTERISTICSANDLOAD FORECASTING	9

Basic definitions – load and load factor definitions - Methods of meeting the load – Interconnected grid system - Load shedding and islanding.

Load Forecasting - Computational methods - Factors affecting load forecasting methods – Simulation, trending, spatial and mixed load forecasting methods.

UNIT III	POWERSYSTEMPLANNING	9

Objectives of planning, long and shortterm planning, planning of generation, transmission and distribution systems. Basics of power system economics - Electricity price forecasting: Issues of pricing and forecasting, Categorisation, Factors, Price simulation model and volatility analysis.

UNIT IV	ELECTRICAL SAFETY MANAGEMENT	9

Hazards of electricity - Principles of safety management - Safety precautions in electrical installations and hazardous areas - Methods of fire prevention - Rescue and first aid procedures - Safety management policy - Regulatory and legal safety requirements and standards - Safety audits.

UNIT V	ENERGYMANAGEMENT	9

Energy needs of growing economy - Energy conservation and its importance - Energy conservation versus energy efficiency - Electrical load management and maximum demand control. Blackout mechanism – prediction and control of blackouts, cascading failures - Energy efficient appliances – Energy saving opportunities - Case study.

TOTAL PERIODS: 45

TEXT BOOKS

1.	S.Sivanagaraju,G.Sreenivasan, 'PowerSystemOperationandControl', PearsonEducation, 2009, 1st Edition.
2.	Hossein Seifi and Mohammad Sadegh Sepasian, 'Electric Power System Planning – Issues, Algorithms and Solutions', Springer, 2011.

REFERENCE BOOKS

1.	Loi Lei Lai. 'Power System Restructuring and Deregulation: Trading Performance andInformation Technology', John Wiley and Sons, Ltd., 2001, 1st Edition.
2.	Turan Goneu, 'Electric Power Distribution Engineering", CRC Press, 2014, 3rd Edition.
3.	John Cadick, MaryCapelli - Schellpfeffer, Dennis Neitzel and Al Winfield, 'Electrical

	SafetyHandbook', McGraw-Hill, 2012, 4th Edition.
4.	Craig B. Smith, Kelly E. Parmenter, 'EnergyManagementPrinciples:Applications, Benefits, Savings', Elsevier, 2015, 2nd Edition.
5.	R. L. Sullivan, 'Power System Planning', McGraw-Hill, 1977.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Analyze thederegulatedenvironmentandpower management	4
2	Realizetheconceptsof load characteristics and loadforecasting	4
3	Examinethe roleof planninginpowersystems	4
4	Investigatetheelectricalsystemsafetyrequirements and management	4
5	Develop knowledge on energy management	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	1	2	2	3	2		2	2		2		3
2	3	3	2	2	3	3	2		2	2		2		3
3	3	3	2	2	3	3	2		2	3		2		3
4	3	2	1	2	2	3	2		2	3		2		3
5	3	2	1	2	2	3	2		2	3		2		3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22028	DIGITAL PROTECTION OF POWER SYSTEM	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Explore recent advancements in electrical power system protection emphasizing on mathematical basis and DSP techniques.
- Devise and design digital protection for power system components.
- Apply decision making methodologies in protective relaying.

UNIT I	INTRODUCTION TO DIGITAL RELAYING	9

Development of digital relaying – Historical background – Expected benefits of digital relaying –Digital relay architecture – Analog to digital converters – Successive approximation ADC, Delta-sigma ADC – Anti-aliasing filters – Substation computer hierarchy.

UNIT II	MATHEMATICAL BASIS FOR PROTECTIVE RELAYING	9

Introduction –Fourier series – Exponential, Sine and cosine Fourier series, Phasors–Other orthogonal expansions–Walsh functions, Fourier transforms – Properties, uses – sampling –Discrete Fourier transform–Introduction to probability and random process–Filtering of random processes–Kalman filtering.

UNIT III	DIGITAL FILTERS	9

Introduction – Discrete time systems – Operations on discrete time sequences, Convolution – Z Transforms – Power series, Inverse Z transforms, Properties of Z transforms, Discrete time fourier transform – Digital filters – Windows and windowing – Linear phase – Approximation − filter synthesis – Wavelets – Elements of artificial intelligence.

UNIT IV	TRANSMISSION LINE RELAYING	9

Introduction – Sources of error – Relaying as parameter estimation – Curve fitting algorithms, Fourier algorithms with shorter windows, Walsh function algorithms, Kalman filter algorithms, Removal of the DC offset – Relay programs based upon fault classification – Symmetrical component distance relay – Newer analytic techniques – Wavelet applications, Agent applications – Protection of series compensated lines.

UNIT V	PROTECTION OF TRANSFORMERS, MACHINES AND BUSES	9

Introduction – Power transformer algorithms –Current derived restraints, Voltage based restraints, Flux restraint –Generator protection –Differential protection of stator windings, Other generator protection functions, Sampling rates locked to system frequency –Motor protection – Digital bus protection.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Phadke, A.G. and J.S. Thorp, Computer Relaying for Power Systems, Research Study Press Ltd, John Wiley and Sons, Taunton, UK, 2009.
2.	Blackburn, J.L. and Domin, T.J., Applied Protective Relaying, CRC Press, New York, 2014.

REFERENCE BOOKS

1.	Anderson, P.M., Power System Protection, IEEE Press, New York, 1999.
2.	Bhavesh Bhalja, R. P. Maheshwari, N. G. Chothani, 'Protection and Switchgear', Oxford University Press, New Delhi, India, 2018, 2nd edition.
3.	Oza, B. A., N. C. Nair, R. P. Mehta, et al., 'Power System Protection and Switchgear', Tata McGraw Hill, New Delhi, 2010.
4.	Bhavesh Bhalja and Vijay H. Makwana, 'Transmission Line Protection Using Digital Technology', Springer ScienceBusiness Media Singapore Pte. Ltd; Singapore, January 2016.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to:		
COs	**STATEMENTS**	**RBT LEVEL**
1	Understand and apply the concepts of digital relaying	3
2	Formulate algorithms for protective relaying.	4
3	Apply digital filtering concepts in developing protective relaying.	4
4	Develop transmission line digital relaying.	4
5	Develop digital protection systems for transformers, machines and buses.	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	1	2		2	2	1	1	2	2	3	2	3
2	3	3	3	3		2	2	1	1	2	2	3	2	3
3	3	3	3	3		2	2	1	1	2	2	3	2	3
4	3	3	3	3		2	2	1	1	2	2	3	2	3
5	3	3	3	3		2	2	1	1	2	2	3	2	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22020	POWER SYSTEM PROTECTION LABORATORY	L T P C
		0 042

COURSE OBJECTIVES

To familiar with

- Faults occurring in power system components, associated protection schemes and characteristics of protective relaying.

LIST OF EXPERIMENTS:

Electromagnetic relays	
1	Study and comparison of various protective devices
2	Simulation of IDMT over current relay characteristics
3	Design and testing of under voltage and over voltage relay
4	Performance analysis of reverse power protection scheme
Simulation of relay coordination	
5	Simulation of relay coordination in radial feeder protection scheme using ETAP / PSCAD / MATLAB Simulink
6	Simulationof relay coordination in parallel feeder protection scheme using ETAP / PSCAD / MATLAB Simulink
Numerical relays	
7	Design and implementation of Numerical Distance relay
8	Design and implementation of Numerical over current Relay
9	Design and implementation of Integrated Numerical under Voltage Relay
Equipment protection	
10	Differential protection of generator using conventional and electrostatic relay
11	Differential protection of transformer using conventional and numerical relay
12	Protection of three phase induction motor using numerical relay
	TOTAL PERIODS: 60

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Study the various power system protective relaying concepts.	2
2	Perform fault analysis and compute the relay design parameters.	4
3	Simulate the characteristics of different relaying concepts.	4
4	Implement protective relaying schemes.	4
5	Analyse the performance of various power system component protection systems.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3		2	2	1	2	2	2	3	2	3
2	3	3	3	3	3	2	2	1	2	2	2	3	2	3
3	3	3	3	3	3	2	2	1	2	2	2	3	2	3
4	3	3	3	3	3	2	2	1	2	2	2	3	2	3
5	3	3	3	3	3	2	2	1	2	2	2	3	2	3
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														

LABORATORY REQUIREMENTS FOR A BATCH OF 30 STUDENTS		
SL.NO	**DESCRIPTION OF EQUIPMENTS**	**QUANTITY REQUIRED**
1.	IMDT over current relay	1
2.	Under voltage relay	1
3.	Over voltage relay	1
4.	Radial feeder protection scheme	1
5.	Parallel feeder protection scheme	1
6.	Numerical Distance relay	1
7.	Numerical over current Relay	1
8.	Integrated Numerical under Voltage Relay	1
9.	Reverse power protection	1
10.	Differential protection of generator using electrostatic relay	1
11.	Differential protection of transformer using numerical relay	1
12.	Protection of three phase induction motor using numerical relay	1

VERTICAL III: ELECTRICAL DRIVES AND CONTROL

EE22031	MODELING AND ANALYSIS OF ELECTRICAL MACHINES	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To provide knowledge about the fundamentals of magnetic circuits, energy, force and torque of multi-excited systems.
- To analyze the steady state and dynamic state operation of DC machine
- To provide the knowledge of theory of transformation of three phase variables to two phase
- variables.
- To analyze the steady state and dynamic state operation of three-phase induction machines using transformation theory.
- To analyze the steady state and dynamic state operation of three-phase synchronous machines using transformation theory

UNIT I	PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION	9

Basics of magnetic circuits - flux, mmf, reluctance - self, leakage, magnetizing and mutual inductances. Analysis of magnetic circuits with air gap and permanent magnets, stored magnetic energy, co-energy - force and torque in singly and doubly excited systems – machine windings and air gap mmf - winding inductances and voltage equation.

UNIT II	MODELING OF DC MACHINES	9

Elementary DC machine and analysis of steady state operation - Voltage and torque equations– dynamic characteristics of permanent magnet and shunt d.c. motors – Time domain blockDiagrams and state equations - solution of dynamic characteristic by Laplace transformation.

UNIT III	REFERENCE FRAME THEORY	9

Static and rotating reference frames – transformation of variables –reference frames-transformation between reference frames –transformation of a balanced set –balanced steady state phasor relationship and voltage equations – variables observed from several frames of reference.

UNIT IV	DYNAMIC ANALYSIS OF INDUCTION MACHINES	9

Three phase induction machine, equivalent circuit and analysis of steady state operation – voltage and torque equations in machine variables and arbitrary- reference frame variables – free acceleration characteristics -analysis of dynamic performance for load torque variations – Dynamic performance during a 3 phase fault at machine terminals.

UNIT V	DYNAMIC ANALYSIS OF SYNCHRONOUS MACHINES	9

Three phase synchronous machine and analysis of steady state operation - voltage and torqueequations in machine variables Stator voltage equations in arbitrary reference frame variables- Voltage equation in rotor reference frame variables (Park's equations) –Analysis of dynamic performance for load torque variations – Dynamic performance during a 3 phase fault at machine terminals.

TOTAL PERIODS: 45

TEXT BOOKS

1	Paul C.Krause, Oleg Wasyzczuk Scott D, Sudhoff, 'Analysis of Electric Machinery andDrive Systems',JohnWiley,IEEE Press, 2013, 3rd Edition.

REFERENCE BOOKS

1	P S Bimbhra, 'Generalized Theory of Electrical Machines', Khanna Publishers, 2008.
2	A.E, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, 'Electric Machinery',

	TataMcGraw Hill, 1992, 5thEdition.
3	Chee-MunOng, Dynamic simulation of Electric machinery using MATLAB / Simulink,Prentice Hall,1997.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Understand the concept magnetic circuits, energy, force and torque of multi-excited systems and derive the voltage and torque equation of different excited systems.	4
2	Derive the mathematical model of a DC motors and analyze the dynamic characteristic by Laplace transformation	4
3	Understand the reference frame theory and its applications to various electrical machines	4
4	Analyze the characteristics of induction machine in steady and dynamic variation of load conditions	4
5	Develop the voltage equations of synchronous machine in rotor reference frames and analyze its dynamic characteristics.	5

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3				1		2		3	3	2
2	3	3	3	3				1		2		3	3	2
3	3	3	3	3				1		2		3	3	2
4	3	3	3	3				1		2		3	3	2
5	3	3	3	3				1		2		3	3	2

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22032	SPECIAL ELECTRICAL MACHINES AND DRIVES	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand the steady state and transient dynamics of a motor- load system.
- To analyze and design a converter/chopper fed DC drive.
- To study and understand the operation and performance of AC motor drives.
- To learn the construction, principle of operation, performance characteristics, control and applications of stepper motors and switched reluctance motor.
- To acquire knowledge of the construction, principle of operation, performance characteristics, control and applications of permanent magnet brushless DC motor and synchronous motors.

UNIT I	DRIVE CHARACTERISTICS	9

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, starting & stopping – typical load torque characteristics – Selection of motors–Energy efficient operation. Introduction to Solar and Battery Powered Drive.

UNIT II	DC MOTOR DRIVE	9

Modeling of DC motors, State space modeling, block diagram & Transfer function Single phase, three phases fully controlled and half controlled converter fed DC drives. Dual converter control of DC drives. Power factor, supply harmonics and ripple in motor current chopper controlled DC motor drives.

UNIT III	AC MOTOR DRIVES	9

Induction motor drive: Stator voltage control- constant air gap flux – slip power recovery scheme. Pulse width modulated inverter fed and current source inverter fed induction motor drive. Volts/Hertz Control, Vector or Field oriented control, Closed loop control.

Synchronous motor drive: Permanent magnet motor –V/f control and self-control of synchronous motor– load commutated thyristor inverter – Margin angle control and power factor control.

UNIT IV	STEPPER MOTOR AND SWITCHED RELUCTANCE MOTOR DRIVES	9

Constructional features – Principle of operation – Variable reluctance motor – Hybrid motor – Single and multi-stack configurations – Torque equations – Modes of excitation – Characteristics – Drive circuits – Types of SRM – Torque production – Steady state performance prediction – Power Converters and their controllers – Methods of Rotor position sensing – Sensor less operation – Characteristics and Closed loop control – applications.

UNIT V	PERMANENT MAGNET MOTOR DRIVES	9

Permanent Magnet materials – Magnetic Characteristics – Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations – Power Converter Circuits and their controllers – Motor characteristics and control – Ideal PMSM – EMF and Torque equations – Synchronous Reactance – Phasor diagram – Torque/speed characteristics – Power controllers – Digital controllers – Applications.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Gopal K.Dubey, 'Fundamentals of Electrical Drives', Narosa, 2010, 2nd Edition.
2.	E.G. Janardanan, 'Special Electrical Machines', PHI learning Private Limited, Delhi, 2014.

REFERENCE BOOKS

1.	S.K.Pillai,, 'A First course on Electrical Drives', New Age International publishers, 2012, 3rd Edition.
2.	R.Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson Education

	India; 2015, 1st Edition.
3.	T. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Oxford Press, 1995.
4.	R.Krishnan, 'Permanent magnet synchronous and brushless dc motor drives', CRC press, 2010.
5.	R.Krishnan, 'Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application', CRC Press, New York, 2001

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Identify the motor and classify types of electric drives systems based on nature of loads and performance characteristics.	4
2	Analyze converter and chopper controlled DC drives.	4
3	Illustrate the various speed control techniques of induction motors and synchronous motor drive.	4
4	Evaluate the performance and analyze the characteristics of stepper motor drive and switched reluctance motor drives.	4
5	Analyse a magnetic circuit and understand the principle of operation of permanent magnet brushless DC and synchronous motor drives	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3				2		2		2	3	1
2	3	3	3	3				2		2		2	3	1
3	3	3	3	3				2		2		2	3	1
4	3	3	3	3				2		2		2	3	1
5	3	3	3	3				2		2		2	3	1

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22033	COMPUTER AIDED DESIGN OF ELECTRICAL APPARATUS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To introduce the fundamentals of Electrical machine design.
- To provide basic electromagnetic field equations and the problem formulation
- To get familiarized with Finite Element Method as applicable for Electrical Engineering.
- To introduce analysis of Finite Element Method
- To explain the basic concepts of electrical machine design by using different computer optimization techniques.

UNIT I	INTRODUCTIONTO MACHINE DESIGN	9

Conventional design procedures – Limitations – Need for field analysisbased design – Review of Basic principles of energy conversion – Development of Torque/Force.

UNIT II	MATHEMATICAL FORMULATION OF FIELD PROBLEMS	9

Electromagnetic Field Equations – Magnetic Vector/Scalar potential – Electrical vector /Scalar potential – Stored energy in Electric and Magnetic fields – Capacitance - Inductance- Laplace and Poisson's Equations – Energy functional.

UNIT III	INTRODUCTION TO FEM	9

Mathematical models – Differential/Integral equations – Finite Difference method – Finite element method – Energy minimization – Variational method- 2D field problems – Discretization – Shape functions – Stiffness matrix – Solution techniques.

UNIT IV	FEM ANALYSIS	9

Elements of a CAD System –Pre-processing – Modeling – Meshing – Material properties- Boundary Conditions – Setting up solution – Post processing.

UNIT V	CAD OF ELECTRICALMACHINE	9

Limitations and assumptions in traditional designs –Need of CAD, analysis, synthesis– design optimization methods, variables, constraints and objective function, problem formulation –Analytical design module– 2D and 3D machine models.

TOTAL PERIODS: 45

TEXT BOOKS

1.	K. M. Vishnu, 'Computer Aided Design of Electrical Machines', B.S. Publications, 2008.
2.	S.J Salon, 'Finite Element Analysis of Electrical Machines', Springer, Yes DEE publishers, Indian reprint, 2007.

REFERENCE BOOKS

1.	Joao Pedro,A.Bastos and NelsonSadowski, 'Electromagnetic Modeling by Finite Element Methods', Marcell Dekker Inc., 2003.
2.	M. G. Say, 'The Performance and Design of A.C. Machines', CBS Publishers and distributors, Delhi, Reprint 2002, 3rd Edition.
3.	M Ramamoorty, 'Computer-Aided Design of Electrical Equipment', John Wiley and Sons.
4.	R. K. Agarwal, 'Principles of Electrical Machine Design', S. K. Kataria and Sons, 2016, New Delhi, 5th Edition.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Understand the fundamentals of Electrical machine design and analyze the electromagnetic field.	3
2	Model Electrical machines based on electromagnetic field equations.	4
3	Understand the fundamentals of Finite Element Method / Finite Difference method to solve design problems	3
4	Modeling and analysis of FEM and FDM using any CAD tool.	4
5	Apply computer aided optimization techniques for design of electrical machines	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3	3			2		2		3	3	3
2	3	3	3	3	3			2		2		3	3	3
3	3	3	3	3	3			2		2		3	3	3
4	3	3	3	3	3			2		2		3	3	3
5	3	3	3	3	3			2		2		3	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22034	SMPS AND UPS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To inculcate knowledge on steady state analysis of Non-Isolated DC-DC converter.
- To perform steady state analysis of Isolated DC-DC converter.
- To impart knowledge on the design of controllers for DC-DC converters.
- To provide conceptual knowledge in modern power electronic converters and its applications in electric power utility.

UNIT I	DC-DC CONVERTERS	9

Buck, Boost, Buck- Boost and Cuk converters: Principles of operation – Continuous conduction mode– Concepts of volt-sec balance and charge balance – Analysis and design based on steady-state relationships- Introduction to discontinuous conduction mode - Applications to Battery operated vehicle.

UNIT II	SWITCHING MODE POWER CONVERTERS	9

Analysis and state space modeling of fly-back, Forward, Luo, half bridge and full bridge converters- control circuits and PWM techniques, design of SMPS - Applications to Battery operated vehicle.

UNIT III	RESONANT CONVERTERS	9

Introduction- classification- basic concepts- Resonant switch- Load Resonant converters- ZVS, Clamped voltage topologies- DC link inverters with Zero Voltage Switching- Series and parallel Resonant inverters- Voltage control.

UNIT IV	AC-DC POWER FACTOR CORRECTION SUPPLIES	9

Single-Phase Single-Stage Non-isolated Boost PFC, Output Capacitor Size, DCM Boost Inductor Selection, CCM Boost Inductor Selection, Design of mutual inductance, High-Power PFC and Load Sharing, Surge Protection, Load Short-Circuit Protection, Three-Phase PFC.

UNIT V	UPS and FILTERS	9

Introduction- Power line disturbances- Power conditioners –UPS: offline UPS, Online UPS, Applications – Filters: Voltage filters, Series-parallel resonant filters, filter without series capacitors, filter for PWM VSI, current filter, Design of transformer for isolated topologies.

TOTAL PERIODS: 45

TEXT BOOKS

1.	M.H. Rashid, 'Power Electronics Circuits, Devices and Applications', Pearson Education, PHI New Delhi, 2017, 4th Edition.
2.	Philip T. Krein, 'Elements of Power Electronics' Oxford University Press, 2009 Edition.

REFERENCE BOOKS

1.	Kjeld Thorborg, 'Power Electronics – In theory and Practice', Overseas Press, 1st Indian Edition 2005
2.	Ned Mohan, Tore.M.Undeland, William.P.Robbins, 'Power Electronics converters,Applications and design', John Wiley and Sons-2007, 3rd Edition.
3.	M.H. Rashid, 'Power Electronics circuits, devices and applications' Prentice Hall of India New Delhi, 2007, 3rd Edition.
4.	Robert W. Erickson and Dragon Maksimovic, 'Fundamentals of Power Electronics', 2020, 3rd Edition.
5.	Simon Ang and Alejandra Oliva, 'Power-Switching Converters', CRC pres, 2011, 3rd edition.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Analyze the behaviors of non isolated DC-DC converters and to design SMPS for battery operated vehicle	4
2	Compute state space averaged model and design Isolated DC-DC converters	4
3	Classification and analysis of resonant converters for SMPS	3
4	Analyze the power factor correction for DC-DC converters using different techniques	4
5	Compare the different topologies of UPS and design the Filters	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	2	1			1		2		3	3	3
2	3	3	3	3	1			1		2		3	3	3
3	3	3	3	3	1			1		2		3	3	3
4	3	3	3	3	1			1		2		3	3	3
5	3	3	3	3	1			1		2		3	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22035	ANALYSIS OF POWER CONVERTERS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To provide the mathematical fundamentals necessary for deep understanding of power converter operating modes.
- To introduce the electrical circuit concepts behind the different working modes of power converters so as to enable deep understanding of their operation.
- To impart required skills to formulate and design inverters for generic load and for machine loads.
- To equip with required skills to derive the criteria for the design of power converters starting from basic fundamentals.
- To inculcate knowledge to perform analysis and comprehend the various operating modes of different configurations of power converters.

UNIT I	AC-DC CONVERTER	9

Single phase and three phase half controlled and fully controlled converters with R-L, R-L-E loads and freewheeling diodes – continuous and discontinuous modes of operation- inverter operation and its limit – Sequence control of converters – performance parameters - reactive power and power balance in converter circuit.

UNIT II	DC-DC CONVERTER DYNAMICS	9

Reactive Elements in Power Electronic Systems, Types of inductor, Types of transformer, Types of Capacitors for power electronic applications - Exact and Approximate Analysis of DC-DC converters, Design and analysis, steady state and dynamic model of Non-isolated DC to DC Power Converter- Buck, Boost, Buck-Boost, Cuk Converters, Isolated DC to DC Power Converter - Forward, Flyback, Half/Full Bridge Converters - Case Study - EMI-EMC Complaints.

UNIT III	RESONANT CONVERTERS	9

Introduction, resonant switch ZCS converter, principle of operation and analysis, resonant switch ZVS converter, principle of operation and analysis, series resonant inverter, series resonant DC-DC converter, parallel resonant DC-DC converter, series- parallel resonant DC-DC converter, resonant converters comparison, resonant DC link converter.

UNIT IV	DC-AC CONVERTERS	9

Principle of operation of single phase half and full bridge inverters – Performance parameters – Voltage control of single phase inverters using various PWM techniques- Three Phase Inverters: 180 degree and 120 degree conduction mode inverters – voltage control of three phase inverters. single, multi pulse, sinusoidal PWM techniques.

UNIT V	MODERN INVERTERS	9

Multilevel concept – diode clamped – flying capacitor – cascaded type multilevel inverters -Comparison of multilevel inverters - application of multilevel inverters – PWM techniques for MLI –Single phase &Three phase Impedance source inverters – Filters.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Rashid M.H., 'Power Electronics Circuits, Devices and Applications', Pearson, 10th Impression 2021, 4th Edition.
2.	Jai P. Agrawal, 'Power Electronics System Theory and Design', Pearson Education, 2015, 1st Edition.

REFERENCE BOOKS	
1.	Bimal.K.Bose,'Modern Power Electronics and AC Drives', Pearson Education,2022, 2nd Edition.
2.	Ned Mohan, T.M.Undeland and W.P.Robbins, 'Power Electronics: converters,Application and design', Wiley, 2007, 3rd edition.
3.	Philip T. Krein, "Elements of Power Electronics" Indian edition Oxford University Press-2017.
4.	P.C.Sen, 'Modern Power Electronics', S.Chand Publishing 2005.
5.	P.S.Bimbra, 'Power Electronics', Khanna Publishers, 2003, 11th Edition,

COURSE OUTCOMES

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

CO's	STATEMENTS	RBT LEVEL
1	Understand the concept and analyze the performance of various converters	4
2	Model, analyze and understand power electronic equipments and DC- Dc converters.	4
3	Apply the concept of resonant converters and conduct performance studies of different resonant converters.	4
4	Carry out performance analysis of inverters with various PWM techniques	4
5	Identify and compare the various types of modern inverters	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3	1			1		2		3	3	2
2	3	3	3	3	1			1		2		3	3	3
3	3	3	3	3	1			1		2		3	3	3
4	3	3	3	3	1			1		2		3	3	3
5	3	3	3	3	1			1		2		3	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22036	PROGRAMMING FOR EMBEDDED SYSTEM	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To expose the students to the fundamentals of embedded Programming
- To Introduce the GNU C Programming Tool Chain in Linux.
- To study the basic concepts of embedded C.
- To impart the basics of Python Programming.
- To learn modules, packages and libraries in Python.

UNIT I	BASIC C PROGRAMMING	9

Typical C Program Development Environment - Introduction to C Programming - Structured Program Development in C - Data Types and Operators - C Program Control - C Functions - Introduction to Arrays.

UNIT II	EMBEDDED C	9

'C' Code: Object oriented programming with C, Header files for Project and Port, Examples. Meeting Real-time constraints: Creating hardware delays - Need for timeout mechanism - Creating loop timeouts - Creating hardware timeouts.

UNIT III	C PROGRAMMING TOOL-CHAIN IN LINUX	9

preprocessor - Stages of Compilation - Introduction to GCC - Debugging with GDB - The Make utility - GNU Configure and Build System - GNU Binary utilities - Profiling - using gprof - Introduction to GNU C Library.

UNIT IV	EMBEDDED PYTHON PROGRAMMING	9

Introduction - Parts of Python Programming Language – Data types and variables- Control Flow Statements – Functions and modules - Strings - Lists - Dictionaries - Tuples and Sets- file handling- Debugging and Testing-Real time operating systems-Memory management

UNIT V	MODULES, PACKAGES AND LIBRARIES IN PYTHON	9

Python Modules and Packages - Creating Modules and Packages - Practical Example - Libraries for Python - Library for Mathematical functionalities and Tools - Numerical Plotting Library - GUI Libraries for Python - Imaging Libraries for Python - Networking Libraries. Embedded related app

TOTAL PERIODS: 45

TEXT BOOKS

1.	Paul Deitel and Harvey Deitel, 'C How to Program', Pearson Education Limited, 2018, 8thEdition.
2.	Ivan Cibrario Bertolotti and Tingting Hu, 'Embedded Software Development', AddisonWesley, CRC Press, 2020.

REFERENCE BOOKS

1.	William von Hagen, 'The Definitive Guide to GCC',Apress Inc., 2006, 2nd Edition.
2.	Gowrishankar S and Veena A, 'Introduction to Python Programming', CRC Press, Taylor and Francis Group, 2019.
3	John Paul Mueller, 'Beginning Programming with Python for Dummies', John Wiley and Sons Inc., 2018, 2nd Edition.
4.	Fabrizio Romano, 'Learn Python Programming', Packt Publishing, 2018, 2nd Edition.
5.	Noel Kalicharan, 'Learn to Program with C', Apress Inc., 2015.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Apply C programming and its salient features for embedded systems.	3
2	Deliver insight into various programming languages/software compatible toembedded process development with improved design & programming skills.	5
3	Develop knowledge on C programming in Linux environment.	5
4	Apply the python programming languagefor Embedded systems	3
5	Investigate modules, packages and libraries in Python for embedded systems	5

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	3	3	3	3	2			1		2		3	2	3
2	3	3	3	3	2			1		2		3	2	3
3	3	3	3	3	2			1		2		3	2	3
4	3	3	3	3	2			1		2		3	2	3
5	3	3	3	3	2			1		2		3	2	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22037	MICROCONTROLLER BASED SYSTEM DESIGN	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To impart the knowledge of architecture of ARM microcontroller and RISC processor.
- To introduce the programming concepts of ARM microcontroller.
- To provide knowledge on the microcontroller based control of permanent magnet synchronous motor.
- To gain knowledge on the microcontroller based control of induction motor.
- To provide knowledge on the microcontroller based control of BLDC motor.

UNIT I	ARM MICROCONTROLLER	9

ARM M Vs ARM R – RISC V architecture, ARM Cortex M: architecture peripherals – memory organization – memory controller – Registers - Interrupts – Interrupt Structure – Timer and Counter –GPIO - SPI, I2C protocol configuration – study of CAN - PWM – DAC – RTOS.

UNIT II	PROGRAMMING ARM MICROCONTROLLER	9

Structures and Pointers, Switches: MOSFET, SIC diodes, Sensor selection: Tachometer, encoders, Sensor response time - Sensor interface with microcontroller - Analog to Digital converter, timers, SPI, I2C, CAN.

UNIT III	MICROCONTROLLER BASED CONTROL OF PERMANENT MAGNET SYNCHRONOUS MOTOR	9

Microcontroller selection: ADC type, resolution, number of GPIO, timers, peripherals – Program Flow Chart - Measurement of non-electrical quantities like voltage current, speed and torque using sensor, representation of variables in digital domain – Implementation of feedback controller - Microcontroller based firing scheme generation for converter and permanent magnet synchronous control.

UNIT IV	MICROCONTROLLER BASED CONTROL OF INDUCTION MOTOR	9

Microcontroller selection: ADC type, resolution, number of GPIO, timers, peripherals – Program Flow Chart - Microcontroller based induction motor control: Measurement of non-electrical quantities like voltage current, speed and torque using sensor, representation of variables in digital domain – Implementation of P, PI and PID controller. Microcontroller based firing scheme generation for inverter and Induction motor control.

UNIT V	MICROCONTROLLER BASED CONTROL OF BLDC MOTOR	9

Microcontroller selection: ADC type, resolution, number of GPIO, timers, peripherals – Program Flow Chart - Microcontroller based BLDC motor control: Measurement of non-electrical quantities like speed, rotor position using Hall effect sensor, representation of variables in digital domain – Implementation of feedback. Microcontroller based firing scheme generation for converters and BLDC motor control.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Alexander G Dean, 'Embedded Systems Fundamentals with Arm Cortex-M based Microcontrollers: A Practical Approach Nucleo-F091RC', Nucleo-F091RC 2021, Arm Education Media, 2nd Edition.
2.	Ariel Lutenberg, Pablo Gomez and Eric Pernia, 'A Beginner's Guide to Designing Embedded System Applications on Arm Cortex-M Microcontrollers', Nucleo-F091RC 202, Arm Education Media, 2nd Edition.

REFERENCE BOOKS

1.	Warren Gay, 'Beginning STM32: Developing with Free RTOS, libopencm3 and GCC',2018,

	Apress,1st Edition.
2.	Sarat Kumar Sahoo, 'Speed Control of Induction Motor Using Microcontroller', 2012, Lambert Academic Publications.
3.	'www.Nuvoton .com/websites' on Advanced ARM Cortex Processors
4.	https://wiki.stmicroelectronics.cn/stm32mcu/wiki/STM32StepByStep:Getting_started_with_Motor_Control
5.	https://wiki.stmicroelectronics.cn/stm32mcu/wiki/STM32MotorControl:Introduction_to_Motor_Control_with_STM32

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Analyze the interconnections of peripherals with CPU, RAM and ROM of ARM microcontroller.	4
2	Apply the knowledge of Programming concepts to the ARM microcontroller.	4
3	Explore the requirements, connections and working of microcontroller based control of Permanent Magnet Synchronous Motor.	5
4	Investigate requirements, connections and working of the microcontroller based control of Induction Motor.	5
5	Investigate the requirements, connections and working of the microcontroller based control of BLDC Motor.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3	3			1		2		3	2	3
2	3	3	3	3	3			1		2		3	2	3
3	3	3	3	3	3			1		2		3	2	3
4	3	3	3	3	3			1		2		3	2	3
5	3	3	3	3	3			1		2		3	2	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22038	CONTROL SYSTEM DESIGN FOR POWER ELECTRONICS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Apply mathematical skills and modelling methods to represent a physical system.
- Design and develop digital controllers to control Power Electronics systems parameters.
- Apply basic concepts of modeling for DC Power Converters.
- To implement the sliding mode controller for DC-DC converters
- Analyze performance of various Power Electronics circuits.

UNIT I	ANALOG CONTROL SYSTEM	9

Review of classical feedback control Review of classical feedback control, Modeling of simple mechanical, electrical, thermal, chemical systems, Transfer functions,Frequency response, Feedback control, Closed loop stability, Linearization of nonlinear models, PD, PI and PID controllers, State space approach for analyzing the dynamic models.

UNIT II	DIGITAL CONTROL SYSTEM	9

Introduction to Digital Controllers: Continuous versus digital control, Sampling theorem, ZOH, effect of sampling rate, Difference Equations, Z transforms, and the Inverse Z transform Discretization of continuous transfer functions; Digital filters, digital controller design using transformation techniques.

UNIT III	MODELLING OF DC-TO-DC POWER CONVERTERS	9

Limitations of linear power supplies, Switched Mode Power Conversion, Switch realization, Modelling of Buck Converter, Boost Converter, Buck-Boost Converter, CUK Converter, SEPIC Converter,

UNIT IV	SLIDING MODE CONTROLLER DESIGN	9

Variable Structure Systems. Single Switch Regulated Systems Sliding Surfaces, Accessibility of the Sliding Surface Sliding Mode Control Implementation of Boost Converter,Buck-Boost Converter, Cuk Converter, SEPIC Converter.

UNIT V	PREDICTIVE CONTROL OF POWER CONVERTERS	9

Basic Concepts, Application of Predictive Control in Power Electronics, AC-DC-AC Converter System, Model Predictive control for power electronic converters, Faults and Diagnosis Systems in Power Converters.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Hebertt Sira-Ramírez PhD, Ramón Silva-Ortigoza, 'Control Design Techniques in Power Electronics Devices', Springer 2012
2.	Mahesh Patil, PankajRodey, 'Control Systems for Power Electronics: A Practical Guide', Springer India, 2015.

REFERENCE BOOKS

1.	R. Erickson and D. Maksimovic, 'Fundamentals of Power Electronics',2001, Springer International Edition, 2nd Edition.
2.	Blaabjerg José Rodríguez, 'Advanced and Intelligent Control in Power Electronics and Drives',Springer, 2014
3.	Enrique Acha, Vassilios Agelidis, Olimpo Anaya, TJE Miller, 'Power Electronic Control inElectrical Systems', Newnes,2002
4.	Marija D. Aranya Chakrabortty, Marija, 'Control and Optimization Methods for Electric SmartGrids', Springer,2012
5.	Ned Mohan, Tore. M. Undel and, William. P. Robbins,'Power Electronics: Converters, Applications and Design', John Wiley and sons, 2003, 3rd Edition,

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Design and apply Analog controller for applications	4
2	Design and apply Digital controller for applications	4
3	Proficient in utilizing advanced modeling techniques to design and analyze DC-DC converters	4
4	Model modern power electronic converters for industrial applications	4
5	Ability to design appropriate controllers for modern power electronicsdevices	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
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				2		2		3	3	3
4	3	3	3	3				2		2		3	3	3
5	3	3	3	3				2		2		3	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22030	ELECTRIC DRIVES LABORATORY	L T P C
		0 0 4 2

COURSE OBJECTIVES

- Evaluate the Load characteristics of DC machines and transformers.
- To impart knowledge on Performance of the fundamental control practices associated with AC and DC machines (starting, reversing, braking, plugging, etc.) using power electronics
- To impart industry oriented learning
- To evaluate the use of computer-based analysis tools to review the major classes of machines and their physical basis for operation.

LIST OF EXPERIMENTS

1.	Speed control of Three phase Slip ring motor using static rotor resistance control through rectifier and chopper circuit.
2.	Design and simulation of three phase induction motor for different load condition.
3.	Control of 3-Phase Induction Motor in constant V/f mode using 3- phase inverter
4.	DC and AC Motor Electrical braking system - study using software / Hardware
5.	Open loop and closed loop speed control of BLDC motor.
6.	PLC based speed control of DC machines
7.	PLC based speed control of AC machines
8.	Induction generator (standalone and grid connected)
9.	To perform the speed control test on slip ring induction motor by rotor resistance control method Using VIRTUAL LAB

TOTAL PERIODS:60

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Identify relevant information to supplement to the Electric Drives.	3
2	Set up control strategies to synthesize the voltages in DC and AC motor drives.	4
3	Develop testing and experimental procedures applying basic knowledge in electronics, electrical circuit analysis, electrical machines, microprocessors, and programmable logic controllers.	4
4	An ability to use standard methods to determine accurate modelling /simulation parameters for various generalpurpose electrical machines and power electronics devices required for designing a system and solve drives related problems	3
5	Combine the use of computer based simulation tools relevant to electrical Drives with practical laboratory experimentation	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	8	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3	1	3	2	1	3	2	1	2	3	
2	3	3	3	3	2	2	2	1	3	2	2	3	3	
3	3	3	3	3	3	3	2	1	3	2	3	3	3	
4	3	3	3	3	3	3	2	1	3	2	3	3	3	
5	3	3	3	3	3	3	2	1	3	2	3	3	3	
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														

LABORATORY REQUIRMENTS FOR A BATCH OF 30 STUDENTS:		
S.NO.	**DESCRIPTION OF EQUIPMENTS**	**QUANTITY REQUIRED**
1.	AC Drives -5 HP	1
2.	IGBT based single phase PWM inverter module/Discrete Component	2
3.	IGBT based three phase PWM inverter module/Discrete Component	2
4.	Microcontroller	3
5.	SIEMENS PLC	2
6.	DC shunt Motor(1HP),	2
7.	Single phase Squirrel cage induction motor (1HP),	2
8.	Slip ring induction motor (2HP)	1
9.	Phase Induction Motor (1HP),	2
10.	Experimental set up for study the closed loop control of BLDC Motor.	1
11.	Computers (I5 processor, 2.7Ghz, 8 GB RAM)	10
12.	Three phase inverter, Power Module and motor drive	2
13.	Isolated Programmable DC power supply	2
14.	Digital multimeter	5
15.	Digital signal oscilloscope	5
16.	Software: MATLAB, SIEMENS PLC software	Each 5 users

VERTICAL IV: ELECTRIC VEHICLE TECHNOLOGY

EE22041	HYBRID ELECTRIC VEHICLES	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand the basic concepts in vehicle dynamics and its performance.
- To acquire proficiency in analyzing and controlling various hybrid electric drive-train topologies.
- To understand and explore electric propulsion and energy storage units for efficient utilization in hybrid electric vehicles.
- To develop skills in component matching, motor sizing, electronics selection, and subsystem integration for efficient drive system design in hybrid and electric vehicles.
- To demonstrate proficiency in understanding and applying control systems, brake configurations, and testing procedures in hybrid electric vehicles.

UNIT I	VEHICLE TRANSMISSION AND PERFORMANCE	9

History of hybrid electric vehicles – Social and environmental importance of hybrid electric vehicles – Performance characteristics of vehicles: Drive cycle characteristics, Basic vehicle dynamics – Calculation of road load – Brief review of Spark Ignition engine, alternative fuel engines – Vehicle transmission: Basics of vehicle performance, vehicle power source characterization, transmission characteristics.

UNIT II	HYBRID ELECTRIC DRIVETRAIN ARCHITECTURE	9

Concept of hybrid electric drivetrains – Architectures of hybrid electric drivetrains: Series hybrid electric drivetrain – Parallel hybrid drivetrain with torque coupling, speed coupling and both – Complex hybrid drivetrain – Fuel-cell hybrid drive train – Plug-in HEV.

UNIT III	ELECTRIC PROPULSION AND ENERGY STORAGE	9

Introduction to electric components used in hybrid vehicles – Overview of Electric drive system: Brushless DC and AC machine, Interior Permanent magnet machine, Asynchronous Machine, Variable reluctance machine – Overview of Energy Storage: Battery system, Capacitor systems, Hydrogen storage, Flywheel systems, Pneumatic systems – Battery model.

UNIT IV	DESIGN OF DRIVE SYSTEM	9

Matching the electric machine and the internal combustion engine (ICE) – Sizing the propulsion motor, sizing the power electronics, and selecting the energy storage technology – Case study: Design Principle and parametric design of Series (electrically coupled) and Parallel (mechanically coupled) hybrid drivetrain.

UNIT V	CONTROL AND BRAKE SYSTEM	9

Function of control system in HEV – Electronic Control Unit (ECU) – Control Area Network (CAN) – Control variables – Brake system of HEV: Parallel hybrid brake system, fully controllable hybrid brake system – Anti-locking brake system – Hybrid vehicle test and validation – Retrofitting of 2-wheeler and 3-wheeler vehicle.

TOTAL PERIODS: 45

TEXTBOOKS

1.	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electricand Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2018, 3rd edition.
2.	John M Miller, 'Propulsion Systems for Hybrid Vehicles', IET, 2010, 2nd edition.

REFERENCE BOOKS	
1.	NPTEL web course: 'Introduction to Hybrid and Electric Vehicles'
2.	Wei Liu, 'Hybrid Electric Vehicle System Modeling and Control', General Motors, USA, John Wiley and Sons, Inc., 2017.
3.	James Larminie, John Lowry, 'Electric Vehicle Technology Explained', Wiley, 2012, 2nd Edition.
4.	Iqbal Hussein, 'Electric and Hybrid Vehicles: Design Fundamentals', CRC Press, 2021, 3rd Edition.
5.	Teresa Donateo, 'Hybrid Electric Vehicles', In-tech Open, 2017.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Understand vehicle performance characteristics, and apply knowledge in designing efficient transmission systems for optimized vehicle performance.	3
2	Comprehend and differentiate various hybrid electric drivetrain architectures	4
3	Select suitable electric drive system and energy storage for hybrid electric vehicles.	4
4	Apply design principles and parametric analysis to develop hybrid drivetrains.	3
5	Comprehend and analyze the functions of HEV control systems, brake technology of hybrid electric vehicles.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	2	2		2	2		2	2		3	3	
2	3	2	3	2		2	2		2	2		3	3	
3	3	2	3	2		2	2		2	2		3	3	
4	3	2	3	2		2	2		2	2		3	3	
5	3	3	3	3		2	2		2	2		3	3	

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22042	VEHICLE DYNAMICS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand the dynamics of vehicle ride under different riding condition.
- To calculate and refer the loads and forces associated to vehicles.
- To analyze the behavior of vehicles under acceleration, ride and braking

UNIT I	BASICS OFVEHICLE DYNAMICS	9

History – Vehicle classifications – Fundamental approaches to vehicle dynamics modelling – SAE Vehicle axis system – Forces & moments affecting vehicle – Earth fixed coordinate system – Dynamic axle loads – Equations of motion – Transmission characteristics – Vehicle performance.

UNIT II	ACCELERATION AND BRAKING PERFORMANCE	9

Power train components – Power and traction limited acceleration – Transverse weight shift – Front wheel drive, rear wheel drive, all-wheel drive vehicles.

Braking force analysis – Rolling resistance, Aerodynamic drag, Grading resistance, Gradeability – Brake design and analysis – Antilock braking system – Wheel lock-up – Tire/road friction – Safety and maintenance issues in braking.

UNIT III	ROAD LOADS AND TIRE DYNAMICS	9

Wind drag and car body design – Breakdowns of total road loads – Gas mileage analysis and driving styles – Aerodynamics

Tire specifications and constructions – Tire motion analysis – Tire force analysis –Tire contact stress analysis – Tire vibration analysis – Tire models.

UNIT IV	STEERING SYSTEM	9

Riding comfort –Vibration sources – Vibration transmission to the passengers – Lower speed cornering – High speed corner – Cornering bicycle model– Quasi-static rollover of a rigid vehicle, Quasi-static rollover of a suspended vehicle – Transient rollover.

UNIT V	CHASSIS AND SUSPENSION SYSTEMS	9

Vehicle and body centre of gravity–Mass moments of inertia– Stiffness and strength–Vibrational behavior– External loads – Chassis structure and components – Multi body models for vehicles – Ride comfort and NVH.

Introduction to suspension system –Components of suspension system – Dependent and independent suspension – Suspension control.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Reza N. Jazar, 'Vehicle Dynamics, Theory and Application', Springer, 2009
2.	Rajesh Rajamani, 'Vehicle Dynamics and Control', Springer, 2012.

REFERENCE BOOKS

1.	Thomas Gillespie, 'Fundamentals of Vehicle Dynamics', SAE Publication, 2021.
2.	Mike Blundell and Damian Harty, 'The Multibody Systems Approach to Vehicle Dynamics', Elsevier, 2004.
3.	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2018, 3rd Edition.
4.	Iqbal Hussein, 'Electric and Hybrid Vehicles: Design Fundamentals', CRC Press, 2021, 3rd Edition.

COURSE OUTCOMES		
Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Analyze the dynamics of vehicle under different riding condition	4
2	Analyze acceleration and braking performance in electric vehicle to understand the vehicle dynamics under these conditions	4
3	Articulate road loads and tire dynamics in electric vehicles	4
4	Interpret riding comfort & vibrations, cornering and roll over in electric vehicles to understand the vehicular dynamics	4
5	Understand the suspension kinematics and controllable suspension elements used in electric vehicles	2
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	2			2		2	2		3	3	
2	3	3	2	2			2		2	2		3	3	
3	3	3	2	2			2		2	2		3	3	
4	3	3	2	2			2		2	2		3	3	
5	3	3	2	2			2		2	2		3	3	

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22043	AUTOMOTIVE POWER ELECTRONICS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To introduce the modern automotive electronics systems based on the application areas and to study about the electronics control engines.
- To impart knowledge of AC-DC, DC-DC and DC-AC converters with emphasize on various automotive applications.
- To provide insight on control of various power converter circuits.
- To gain the knowledge automotive standards to design the converters for EVs.

UNIT I	INTRODUCTION TO AUTOMOTIVE ELECTRONICS	9

Introduction to Modern Automotive Systems – Evolution of Automotive Electronics – Need for electronics in automobiles – Application areas of electronic systems in modern automobiles: Electronics Engines Control, Electronics Fuel Control, Electronics Ignition, Automotive transmissions – Electronic Control Unit (ECU) design cycle – Components of ECU – Examples of ECU's in automotive.

UNIT II	AC-DC AND DC-DC CONVERTERS FOR EVs	9

AC-DC converters – Uncontrolled rectifiers – Performance parameters (power factor correction, harmonic factor) – DC-DC converters for automotive applications – Design and analysis of Buck-Boost converter – Four quadrant DC-DC converter – PWM control of DC-DC converters – Low voltage electrical loads in EV and Auxiliary Power Modules – Case study on control techniques of converters.

UNIT III	CONVERTER TOPOLOGIES	9

Converter topologies for auxiliary power modules – Fly-back, forward, push-pull, Full bridge, Bidirectional DC-DC converters for EV charging applications – Typical specifications of power converters – Design of power circuit to meet the specifications – Case study on topologies of the converter and its significance.

UNIT IV	DC-AC CONVERTERS FOR EVs	9

DC-AC converters – Voltage source inverters – Single and three phase inverter – Sinusoidal PWM and Space vector PWM – DC side current of PWM inverter – Current regulated PWM – Rectifier and inverter Mode of operation – G2V and V2G operation in EVs – Introduction to Cascaded H-bridge Multilevel inverters.

UNIT V	DESIGN CONSIDERATIONS AND AUTOMOTIVE STANDARDS	9

Design of Heat sinks – Snubber circuits and driver circuits – Magnetic design – Energy storage requirements for EV – Battery management systems – Simulation tools for power converters – Relevant automotive standards – Automotive design considerations – Power conditioning in power converters – High temperature applications – Case study on converter design for EVs with its automotive standards.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Emadi,Ali, 'AdvancedElectricDriveVehicles',CRCPress,2014.
2.	William Ribbens, 'Understanding Automotive Electronics', Butterworth Heinemann, 2017, 8th edition.

REFERENCE BOOKS

1.	Randall Shaffer, 'Fundamentals of Power Electronics with MATLAB', Firewall Media,2013.
2.	WengangWayneBi,HaochungHenryKuo,PeichengKu,andBoShen,eds.,

	'HandbookofGaNSemiconductorMaterialsandDevices,CRCPress,2017.
3.	DanielHart, 'PowerElectronics', McGraw-Hill,2011.
4.	Ned Mohan, Tore M. Undeland and William P.Robbins, 'Power Electronics, Converters,Applications and Design', John Wiley and Sons Inc., 2006, 3rd edition.
5.	MuhammadH.Rashid, 'PowerElectronics,Circuits,Devicesand Applications',Pearson, 2014, 4th edition.

COURSE OUTCOMES

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

CO's	STATEMENTS	RBT LEVEL
1	Understand the concept of automotive electronics and control of various subsystems.	2
2	Analyze the performance parameters of DC-DC converters for automotive applications.	4
3	Analyze the various topologies for power electronic converters and their auxiliary elements for automotive applications.	4
4	Understand the operation of dc-ac converters and analyze the suitability for automotive applications.	4
5	Evaluate the performance of various power electronic components with relevant automotive standards	5

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	2					2	2		3	3	
2	3	3	2	2					2	2		3	3	
3	3	3	2	2					2	2		3	3	
4	3	3	2	2					2	2		3	3	
5	3	3	2	2					2	2		3	3	

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22044	ENERGY STORAGE SYSTEM AND MANAGEMENT IN EV	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand the fundamentals of EV batteries and analyze different battery technologies used in EVs, their characteristics and limitations.
- To explore charging infrastructure systems, including types, standards, and smart charging strategies.
- To discuss the latest advancements and future trends in EV battery technology and energy management.

UNIT I	EV BATTERIES	9

Overview of Electric Vehicles (EVs) – Importance of Energy Storage in EVs – Comparison of different energy storage technologies – Role of batteries in EVs – Battery basics: electrochemical principles, cell components – types of batteries (lead-acid, NiMH, Li-ion, solid-state) – Selection of battery for EVs & HEVs – Battery performance parameters: capacity, energy density, power density, cycle life, charging/discharging characteristics.

UNIT II	BATTERY TECHNOLOGIES FOR EVs	9

Lithium-ion Batteries – Chemistry, characteristics, types (LCO, LFP, NMC, etc.), performance advantages and limitations – Solid-state battery technology: advantages and challenges, potential for improved performance and safety – Lithium-sulfur batteries – Advanced battery technologies – Battery management systems (BMS): Importance of BMS in EVs, functions, components, cell balancing, thermal management, safety features – Battery degradation and aging mechanisms – methods for extending battery life.

UNIT III	CHARGING INFRASTRUCTURE AND STANDARDS	9

EV Charging Infrastructure – Types of charging stations: AC and DC chargers – Charging standards (SAE J1772, CHAdeMO, CCS), charging speeds and power levels, deployment strategies. Smart charging concepts: grid-to-vehicle (G2V), vehicle-to-grid (V2G), dynamic pricing, load balancing – Renewable energy integration with EV charging infrastructure: solar, wind, and other sources.

UNIT IV	SUPERCAPACITOR AND FUEL CELL	9

Supercapacitors: Working principle, types of supercapacitors – cycling and performance characteristics – difference between battery and supercapacitors – Introduction to Hybrid electrochemical supercapacitors. Fuel cell: Operational principle of a fuel cell, types of fuel cells – hybrid fuel cell-battery systems, hybrid fuel cell-supercapacitor systems.

UNIT V	CHALLENGES AND FUTURE TRENDS IN ENERGY STORAGE	9

Environmental impact of battery production and disposal, life cycle assessment – Safety concerns – Cost considerations – Research and Development in EV Energy Storage – Next-generation materials, improved capacity and safety, recycling and sustainability Innovations in battery technology – Policy and regulatory frameworks for promoting EV technology and infrastructure development.

TOTAL PERIODS: 45

TEXT BOOKS

1.	James Larminie and John Lowry, 'Electric Vehicle Technology Explained', Wiley, 2012, 2nd edition.
2.	David Linden and Thomas Reddy, 'Handbook of Batteries', Tata McGraw Hill, 2001, 3rd edition.

REFERENCE BOOKS

1.	Gianfranco Pistoia and Boryann Liaw, 'Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost (Green Energy and Technology),

	Springer 2018.
2.	Albert Link, Alan O'Connor, Troy Scott, 'Battery Technology for Electric Vehicles: Public Science and Private Innovation,' Routledge, 2015.
3.	MehrdadEhsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2018, 3rd edition.
4.	Iqbal Hussein, 'Electric and Hybrid Vehicles: Design Fundamentals', 3rd edition, CRC Press, 2021.
5.	Electric Vehicle Charging Technology and Standards by IEEE Standards Association
6.	Joao Abel Pecas Lopes, Rodrigo Garcia-Valle, 'Electric Vehicle Integration into Modern Power Networks', Springer, 2016

COURSE OUTCOMES

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

COs	**STATEMENTS**	**RBT LEVEL**
1	Understand the basics of various energy storage systems and analyze its suitability for electric vehicles.	4
2	Apply the concepts of battery management system and design the battery pack.	4
3	Understand the design and deployment considerations of charging infrastructure and discuss interoperability challenges and solutions.	3
4	Design and develop hybrid energy storage systems to improve EV range and performance.	4
5	Identify and analyze challenges related to energy storage for electric vehicles and suggest suitable solutions.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	3	3	2	2			2		2	2		3	3	2
2	3	3	3	2			2		2	2		3	3	2
3	3	3	2	2			2		2	2		3	3	2
4	3	3	3	2			2		2	2		3	3	2
5	3	3	2	2			2		2	2		3	3	2

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22045	ELECTRIC VEHICLE CONTROL	L T P C
		3 0 0 3

COURSE OBJECTIVE

- Understand the control architectures of electric vehicle drivetrain and concept of power converters in electric vehicle.
- Acquire knowledge on drivetrain characteristics and analysis on electric vehicles based on vehicle parameters and types of loads.
- Study about the various control strategies of electric vehicles.

UNIT I	REVIEW OF CONVENTIONAL VEHICLE	9

Introduction to electric vehicles: Electric drivetrain – Tractive effort in normal driving – Energy consumption concept of Electric drivetrain and its architecture – Electric propulsion unit – Various Hybrid/EV architectures – Various switched mode DC/DC converters for EV drive – Construction and operation of speed control using acceleration pedal.

UNIT II	ROLE OF POWER CONVERTERS IN DRIVES	9

DC-DC converters: Buck-boost, bidirectional DC-DC converters – Effect of parasitic elements, performance analysis – Controllers design for DC-DC converters – Single-phase and three-phase inverter, VSI and CSI topologies – PWM techniques – Hysteresis control – Comparison of PWM techniques and closed loop control of drives.

UNIT III	CHARACTERISTICS – MODELING AND ANALYSIS OF EV	9

Transmission and drivetrain characteristics – Regenerative braking characteristics – Driving cycles – Modelling and analysis of electric vehicles propulsion and braking – Longitudinal dynamics equation of motion.

UNIT IV	ELECTRIC VEHICLE DRIVETRAIN EFFICIENCY	9

Drive efficiency: impact of altitude, ambient temperature, gradient and motors – Different type of motors used and its comparative study – Torque vs speed – Calibration of drivetrain based on vehicle parameters. EV design and components sizing – Electric drivetrain overview, Systems with Linear Motion and Rotating Systems, Types of loads, Four Quadrant Operation. Induction Motor for EV power train, Variable Voltage Variable Frequency Control – Steady State Analysis of Induction Drive, Direct & Indirect Vector Control, and Direct Torque Control.

UNIT V	CONTROL STRATEGIES OF EV	9

BLDC drives-various speed control strategies – closed loop control – Autonomous control. Control strategies of regenerative braking in drives. Speed control of AC drives. Permanent magnet synchronous machine for EV power train, Non-Salient & Salient Drives, Generic Model, Steady State Analysis, Field Oriented Control – Switched Reluctance Machine for EV power train – Operating principles, Analysis of SRM drives and speed control – Multi-input EV drives concepts and their operation.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Ali Emadi, "Handbook of Automotive Power Electronics and Drives", Taylor and FrancisGroup, 1st edition, USA, 2005.
2.	David Crolla, Behrooz Mashadi, "Vehicle Powertrain Systems", January 2012, Wiley
3.	Tom Denton, 'Automotive Electrical and Electronic Systems', Routledge, Taylor andFrancis Group, 2017, 5th edition.

REFERENCE BOOKS	
1.	Bimal K Bose, 'Modern Power Electronics and AC Drives', Pearson Education, 2003, 2nd edition.
2.	P.C. Sen, 'Modern Power Electronics', Wheeler Publishing Co, New Delhi, 2008, 3rd edition.
3.	Wei Liu, 'Hybrid Electric Vehicle System Modelling and Control', General Motors, USA,John Wiley & Sons, Inc., 2017.
4.	Gianfranco Pistoia, 'Electric and Hybrid Vehicles Power Sources, Models, Sustainability,Infrastructure and the Market Consultant', Rome, Italy, Elsevier Publications, 2017.
5.	R Krishnan, 'Electric motor drives: Modelling, Analysis, and Control', 2013.

COURSE OUTCOMES

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

CO's	STATEMENTS	RBT LEVEL
1	Acquire knowledge about various types of power trains utilized in EV drives	3
2	Acquire knowledge about various converters utilized in EV drives	3
3	Develop capability to model drives and braking characteristics-involving load estimation, load cycle considerations, thermal aspects and motor-converter matching	4
4	Analyse the various controllers used in DC and AC drives	4
5	Design and analyse various power converters used in Electrical Drives and their control.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	1	1		3	3		2	2		3	3	
2	3	3	1	1		3	3		2	2		3	3	
3	3	3	1	3		3	3		2	2		3	3	
4	3	3	1	3		3	3		2	2		3	3	
5	3	3	1	3		3	3		2	2		3	3	

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22046	AUTOMOTIVE EMBEDDED SYSTEMS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Introduce the basic Embedded System and its sub-system categories.
- Impart the automotive product design cycle with concept to market.
- Inculcate the concepts of automotive sensors and software.
- Learn about the verification and validation process using NI LabVIEW.

UNIT I	AUTOMOTIVE EMBEDDED SYSTEM OVERVIEW	9

Automotive embedded system technology – Overview of embedded system categories – Various embedded sub systems for chassis, body, driveline, engine, fuel, emission, brakes, suspension, emission, brakes, suspension, doors, safety & security – Comfort & Multimedia – Communication & Lighting – Future trends in automotive embedded systems: X by wire technologies.

UNIT II	AUTOMOTIVE HARDWARE MODULE	9

Concept to market: Understanding automotive product design cycle – Microcontroller, architecture, Memory map, I/O map – Building Blocks of Automotive Electronic Product: Actuators, Sensors, Semiconductor Components, Devices, Integrated Circuits (ICs), Relay, Stepper motor, PCBs etc.

UNIT III	AUTOMOTIVE SENSORS	9

Automotive Sensors and Transducers: Temperature, Force, Oxygen Sensor, LAMBDA Sensor, Proximity Distance Sensors, Speed, Engine knock sensor, Resistive potentiometer & Flow. typical sensors specifications & Microcontroller interfacing, Signal processing circuit, Sensor calibration.

UNIT IV	AUTOMOTIVE SOFTWARE PROTOCOLS	9

Need for Protocol – Automotive Protocols: LIN, CAN, KWP2000 & J1939, FlexRay, Test, Calibration and Diagnostics tools for networking of electronic systems like ECU software and testing tools, ECU calibration tools, Vehicle network simulation – Advanced trends in automotive electronics: AUTOSAR architecture.

UNIT V	VERIFICATION & VALIDATION	9

Validation and verification process, Introduction to NI LabVIEW for Automotive, Test Categories: Functional test, Black Box test, Boundary level test & Test case development, Reliability and certifications tests, EMI / EMC tests as per AIS 004 standard, Environmental test, Vibration tests, Protection against dust, Water ingress and ip standards vehicle diagnostic interface like OBD, OBD - II.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Nicolas Navet and Francoise Simonot-Lion, 'Automotive Embedded SystemsHandbook',CRC Press,2009.
2.	Miroslaw Staron, 'Automotive Software Architectures: An Introduction', Springer,2017.

REFERENCE BOOKS

1.	RonaldK.Jurgen, 'AutomotiveSoftware',SAEInternational,2006.
2.	Robert Bosch, 'Automotive Hand Book', SAE Publications, 2003, 5th edition.
3.	William B Ribbens, 'Understanding Automotive Electronics – An Engineering Perspective', Butterworth-Heinemann Publications, 2012, 7th edition.

4.	Ronald K. Jurgen, 'Distributed Automotive Embedded Systems' , SAE International,2007.
5.	Kiencke, Uwe, Nielsen & Lars, 'Automotive Control Systems for Engine, Driveline and Vehicle', Springer Publications, 2005, 2nd edition.

COURSE OUTCOMES

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

CO's	STATEMENTS	RBT LEVEL
1	Categorize the major components of various automotive embedded sub systems and its future trends.	4
2	Understand the automotive hardware module using product design cycle with concept to market.	3
3	Apply the concepts of different automotive sensor to compute its various parameters.	3
4	Learn about the automotive softwares and follow its coding standards and guidelines.	5
5	Verification and validation of automotive relevant to protection through various test cases.	5

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	1	1	1	3	3		3	1		3	3	
2	3	3	1	1	1	3	3		3	1		3	3	
3	3	3	1	3	1	3	3		3	1		3	3	
4	3	3	1	3	1	3	3		3	1		3	3	
5	3	3	1	3	1	3	3		3	1		3	3	

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22047	VEHICLE COMMUNICATION	L T P C
		30 0 3

COURSE OBJECTIVES

- To understand the concepts of in-vehicle networking and its importance in modern vehicle systems.
- To explain the various network and communication protocols used in automotive applications.
- To differentiate between different network and communication protocols employed in-vehicle communication systems.
- To describe the FlexRay protocol and its significance in automotive communication for real-time data transmission.
- To identify and analyze the latest trends in in-vehicle networking, considering advancements in technology and industry standards.

UNIT I	BASICS OF IN-VEHICLE NETWORKING	9

Overview of Data communication and networking – Need for In-Vehicle networking – Layers of OSI reference model – Multiplexing and de-multiplexing concepts – Vehicle buses.

UNIT II	NETWORKS AND PROTOCOLS	9

Overview of general-purpose networks and protocols: Ethernet, TCP, UDP, IP, ARP, RARP - LIN standard overview – workflow applications – LIN protocol specification – signals - Frame transfer –Frame types – Schedule tables – Task behavior model – Network management – status management - overview of CAN fundamentals – Message transfer – frame types-Error handling – fault confinement – Bit time requirements.

UNIT III	HIGHER LAYER PROTOCOL	9

Introduction to CAN open –TTCAN, Device net -SAE J1939 – overview of data channels – Control channel-synchronous channel – asynchronous channel – Logical device model – functions, methods, properties – protocol basics - Network section-data transport – Blocks – frames – Preamble-boundary descriptor.

UNIT IV	FLEXRAY PROTOCOL	9

Introduction – Network topology – ECUs and bus interfaces – Controller host interface and protocol operation controls – Media access control and frame and symbol processing – Coding/decoding unit – FlexRay scheduling.

UNIT V	LATEST TRENDS	9

Car networking protocols – Networking future trends – Roadmaps – Competitive advantage – Recent advancement of network architectures for vehicular communications – Case studies on automotive manufacturers industry.

TOTAL PERIODS: 45

TEXTBOOKS

1.	J.Gabrielleen, 'Automotive In-Vehicle Networks', John Wiley and Sons Limited, 2008
2.	Robert Bosch, 'Bosch Automotive Networking', Bentley publishers, 2007
3.	Society of Automotive Engineers 'In-Vehicle Networks', 2002

REFERENCE BOOKS

1.	Ronald K Jurgen, 'Automotive Electronics Handbook', McGraw-Hill Inc. 1999
2.	IndraWidjaja, Alberto Leon-Garcia, 'Communication Networks: Fundamental Concepts and Key Architectures', McGraw-Hill College, 2003.

3.	KonradEtschberger, 'Controller Area Network, IXXAT Automation', August 22, 2001
4.	Olaf Pfeiffer, Andrew Ayre, Christian Keydel, 'Embedded Networking with CAN and CANopen', Annabooks/Rtc Books, 2003

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Analyze about in-vehicle networking	4
2	Comprehend the different network and communication protocols.	4
3	Realize the different higher level protocols.	4
4	Classify the configuration of FlexRay protocol	4
5	Apply the latest trends in in–vehicle networking.	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2	2	2	2					1	1		3	2	
2	2	2	2	2					1	1		3	2	
3	2	2	2	2					1	1		3	2	
4	2	2	2	2					1	1		3	2	
5	2	2	2	2					1	1		3	2	

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22048	SUSTAINABLE EV CHARGING INFRASTRUCTURE	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Understand the various EV chargers, charging modes and the difficulties associated with EV battery charging.
- To gain the knowledge of Charger classification, connector and cable, EVSE testing procedures, and standards
- To provide insight on various communication protocol, billing and authentication used in EV charging
- To understand recent trend and implementation of public charging stations policy and economic aspects, protection and safety standards
- To gain the knowledge of future charging methods integration of charging station impact of grid connected system.

UNIT I	SIZING AND STANDARDS OF EV CHARGERS	9

Electric vehicle charging – Charging modes – Electric vehicle supply equipment (EVSE): Types, components of EV battery chargers – Challenges in EV charging – Selection and sizing of chargers – Charger connectors and cables – Charging standards: connectors, supply equipment; EMI/EMC – testing methods for chargers and EVSE.

UNIT II	RENEWABLE ENERGY INTEGRATION IN EV CHARGING	9

Importance of renewable energy integration for sustainable transportation – Solar powered charging stations – Wind powered charging stations – design principles and components – Hybrid charging station – Case studies.

UNIT III	EV CHARGER COMMUNICATIONS PROTOCOLS	9

Open Charge Point Protocol (OCPP) – Open System Interconnection layer model (OSI) – Adapted PWM signal based low-level communication – PLC based high-level communication – CAN communication – Billing and authentication.

UNIT IV	PUBLIC CHARGING INFRASTRUCTURE	9

Location, planning and implementation of public charging stations – Components – Selection and sizing: HT/LT equipment and cables – Protection – Safety standards: Policy and regulatory aspects – EV charging station and their business models – Economic aspects – Major challenges.

UNIT V	FUTURE FRONTIERS IN EV CHARGING	9

Bulk charging – Battery swapping – Wireless charging – EVs as distributed storage resources: Grid to Vehicle (G2V) and Vehicle to Grid (V2G), V2X concept – Smart grid integration and demand response strategies for optimizing EV charging.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Iqbal Husain, 'Electric and Hybrid Vehicles: Design Fundamentals', CRC Press, 2021, 3rd Edition.
2.	Code of Practice for Electric Vehicle Charging Equipment Installation, IET, 2020, 4th Edition

REFERENCE BOOKS

1.	Sheldon S. Williamson, 'Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles', Springer, 2013, 1st Edition.
2.	Tom Denton, 'Automotive Electrical and Electronic Systems', Routledge, 2018, 5th Edition.

3.	Wolfhard Lawrenz, 'CAN System Engineering: From Theory to Practical Applications', Springer, 2013, 2nd Edition.
4.	Sandeep Dhameja, 'Electric Vehicle Battery Systems', Newnes, 2002.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Understand the various components of Electric vehicle charging system	2
2	Comprehend the different types of Electric vehicle chargers and their standards	4
3	Analyze the many communication protocols that are employed when charging electric vehicles.	4
4	Familiarize with the recent trends in Electric vehicle charging	4
5	Prospects for EV charging using renewable energy sources and their effect on the grid	2

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3			3		2	2		3	3	2
2	3	3	3	2			3		2	2		3	3	3
3	3	3	3	3			3		2	2		3	3	2
4	3	3	3	3			3		2	2		3	3	3
5	3	3	3	3			3		2	2		3	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22040	ELECTRIC VEHICLE LABORATORY	L T P C
		0 0 4 2

COURSE OBJECTIVES

- To model, simulate and evaluate the performance of Electric Vehicle system components.

LIST OF EXPERIMENTS	
1.	Acceleration Performance of an Electric Vehicle.
2.	Importing and Creating Standard Driving Cycles.
3.	Design, Modeling and Simulation of Battery Systems.
4.	Dynamic performance of a Battery for a set power.
5.	Modeling and Simulation of Range of an Electric Four wheeler.
6.	Modeling and Simulation of Range of an Electric Two wheeler.
7.	Speed control characteristics of an Electric Vehicle Two wheeler.
8.	Simulation of Range of Fuel Cell Electric Vehicle
9.	Performance analysis of Electric Vehicle Drive Motor.
10.	Simulation of Periodic CAN Message Transmission Behavior.
11.	Design, Modeling and Performance analysis of Battery Electric Vehicle using MATLAB/Simulink.
12.	Design, Modeling and Performance analysis of a Battery for an Electric Vehicle based on Modelica.

TOTAL PERIODS:60

COURSE OUTCOMES

At the end of the course, the student should be able to:

COs	STATEMENTS	RBT LEVEL
1	Identify and adopt standard drive cycles to simulate vehicle performance.	4
2	Develop mathematical model for EV system components.	4
3	Simulate EV systems and evaluate their performance.	4
4	Establish communications in vehicles adopting to prescribed standards/protocols.	4
5	Integrate the system components, simulate and evaluate the performance of EVs.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3	3	1			2	2		3	3	
2	3	3	3	3	3	1			2	2		3	3	
3	3	3	3	3	3	1			2	2		3	3	
4	3	3	3	3	3	1			2	2		3	3	
5	3	3	3	3	3	1			2	2		3	3	
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														

LABORATORY REQUIREMENTS FOR A BATCH OF 30 STUDENTS		
SL.NO	**DESCRIPTION OF EQUIPMENTS**	**QUANTITY REQUIRED**
1.	Personal Computers (Intel i3 Processor, 500GB HDD, 8GB Ram)	30 Nos.
2.	Printer HP Laser Jet 1020 Plus	1 No.
3.	Server (IBM X 3300 M4 Server & Fedora 14)	2 Nos.
SOFTWARE		
4.	MATLAB Full Suite	Campus Wide License
5.	OpenModelica	Open source

VERTICALV: RENEWABLE ENERGY AND ENGINEERING

EE22051	DISTRIBUTED GENERATION AND MICROGRID	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand the various energy sources and conversion of useful energy.
- To illustrate needs of various distributed generations.
- To examine the various distributed generations and installations.
- To outlinethe various micro-grid structures and interfacing with power electronic units.
- To analyze the control methods and stability in Micro-grids

UNIT I	INTRODUCTION	9

Conventional power generation: advantages and disadvantages, Energy crises, Non-conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources. Impact of grid integration of NCE sources on existing power system: reliability, stability and power quality issues, Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants.

UNIT II	DISTRIBUTED GENERATIONS (DG)	9

Concept of distributed generations, topologies, selection of sources, concept and topologies, renewable energy in distributed generation. IEEE 1547 Standard for interconnecting distributed generation to electric power systems.

UNIT III	DG INSTALLATIONS	9

Classes, requirements for grid interconnection, limits on operational parameters: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues, security issues in DG implementations. Siting and sizing of DGs – optimal placement – regulatory issues.

UNIT IV	BASICS OF A MICROGRID	9

Introduction to microgrids – types – structure and configuration of microgrids – AC and DC microgrids – power electronic interfaces in DC and AC microgrids, impact of grid integration on existing power systems.

UNIT V	CONTROL AND OPERATION OF MICROGRID	9

Modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communicationbased techniques.Power quality issues in microgrids, regulatory standards, Microgrid economics, Introduction to smart microgrids.

TOTAL PERIODS: 45

TEXT BOOKS

1. Amirnaser Yezdani, and Reza Iravani, 'Voltage Source Converters in PowerSystems: Modeling, Control and Applications',IEEE John Wiley Publications, 2010.
2. Robert Lasseter, Paolo Piagi, 'Micro-grid: A Conceptual Solution', PESC 2004, June 2004.

REFERENCE BOOKS

1. J.F. Manwell, J.G. McGowan **'**Wind Energy Explained, theory design andapplications**'**,Wiley publication 2010.
2. John Twidell and Tony Weir,**'**Renewable Energy Resources**'** Tyalor and FrancisPublications, 2006, 2nd Edition.
3. Gregory W. Massey, "Essentials of Distributed Generation Systems", Jones and Bartlett Publishers.

4.	Ali Keyhani,'Design of Smart Power Grid Renewable Energy Systems', John Wiley and Sons.
5.	DorinNeacsu, 'Power Switching Converters: Medium and High Power', CRCPress, Taylor and Francis, 2006.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Understand the principles of energy conversion in renewable and distributed energy sources.	2
2	Demonstrate the concept of Distributed generations and its various topologies.	3
3	Analyze the various issues of grid integration with distributed generations.	4
4	Articulate the types, structure and configuration of microgrids.	3
5	Analyze the operation of microgrid and control strategies in economic point of view.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	1	2	1	3	2	2	3	1	3	3	1	3
2	3	2	1	2	1	3	2	2	3	1	3	3	1	3
3	3	4	1	3	1	3	2	2	3	1	3	3	1	3
4	3	2	1	2	1	3	2	2	3	1	3	3	1	3
5	3	4	1	3	1	3	2	2	3	1	3	3	1	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22052	SOLAR ENERGY CONVERSION SYSTEM	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To study the solar energy at the earth's surface and its measurements.
- To learn about various energy storage technologies.
- To study the energy conversion in solar modules and design the PV-based system.
- To discuss the standalone and grid-connected PV systems.
- To describe in detail the upcoming applications of solar photovoltaic systems.

UNIT I	SOLAR RADIATION	9

Solar Energy – Indian Scenario – government policy- solar projects in India- future challenges. Sun as a source of energy, Solar radiation, Solar radiation at the Earth's surface, Measurement of Solar radiation-Pyroheliometer, Pyranometer, Sunshine recorder, Predictionofavailablesolar radiation,Solarenergy-Importance,Storageofsolar energy,Solarpond.

UNIT II	SOLAR THERMAL SYSTEMS	9

Principle of conversion of solar radiation into heat, Collectors used for solar thermal conversion: Flat plate collectors and Concentrating collectors- Solar Thermal Power Plant, Solarcookers, solar hot water systems,solardryers,Solar Distillation,Solar green houses.

UNIT III	SOLAR PHOTOVOLTAIC	9

Conversion of Solar energy into Electricity - Photovoltaic Effect, Solar photovoltaic cell and its working principle, Different types of Solar cells, Series and parallel connections.

UNIT IV	STAND ALONE AND GRID CONNECTED PV SYSTEM	9

Solarmodules–storagesystems–powerconditioningandregulation-MPPT-protection–standalone PV systems design –sizing-Applications-Battery chargers, domestic lighting, street lighting, Grid connected PV systems in buildings – design issues for central power stations.

UNIT V	FUTURE APPLICATIONS OF SOLAR PV	9

PV for transport -solar races, solar planes, solar boats- smart grids-Floating Solar PV Plants- Agrivoltaics-AI in solar engineering, and integrating PV.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Solar Energy Utilization, G.D. Rai, Khanna Publishers, 2008
2.	Solar Energy Fundamentals, design, modeling & applications, G.N.Tiwari, Narosa Pub.2005.

REFERENCE BOOKS

1.	Solanki C.S., 'Solar Photovoltaics: Fundamentals, Technologies andApplications',PHI LearningPvt.Ltd.,2015.
2.	S.P.Sukhatme, 'Solar Energy-Principles of thermal energy collection and storage', Tata Mc-Graw Hill Publishers, 1999.
3.	Eduardo Lorenzo G. Araujo, 'Solar electricity engineering of photovoltaicsystems',Progensa,1994.
4.	P.Jayarama Reddy, 'Science and Technology of Photovoltaics',BS Publications,2009, 2nd Edition.
5.	Frank S. Barnes and Jonah G. Levine, 'Large Energy storage Systems Handbook', CRCPress,2011.

COURSE OUTCOMES		
Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Acquire knowledge of solar radiation principles with respect to solar energy estimation.	3
2	Become familiar with various collecting techniques for solar energy and its storage.	3
3	Learn the principles of solar photovoltaic technology and the different types of solar cells for energy conversion.	3
4	Design and size the PV panel for the standalone systems and the grid-connected systems.	3
5	Learn about future transport applications and smart applications using solar PV.	3
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3		2	3			2		2	1	3
2	3	3	3	3		2	3			2		2		3
3	3	3	3	3		2	3			2		2	1	3
4	3	3	3	3		2	3			2		2	3	3
5	3	3	3	3		2	3			2		2	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22053	WIND ENERGY CONVERSION SYSTEM	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To learn about the basic concepts of wind energy conversion system
- To learn the design and control principles of Wind turbine.
- To understand the concepts of fixed speed wind energy conversion systems.
- To understand the concepts of Variable speed wind energy conversion systems.
- To discuss the grid integration issues.

UNIT I	INTRODUCTION	9

Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-Power coefficient-Sabinin'stheory-Aerodynamics of Wind turbine- Impact of Tower Height- Maximum Rotor Efficiency- Environmental Impacts of Wind Turbines.

UNIT II	WIND TURBINES	9

HAWT-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-stallcontrol-Schemesformaximumpower extraction--floating wind turbines.

UNIT III	FIXED SPEED SYSTEMS	9

GeneratingSystems-Constantspeedconstantfrequencysystems-ChoiceofGenerators-Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of WindSpeed- Model wind turbine rotor - Drive Train model- Generator model for Steady state andTransientstabilityanalysis.

UNIT IV	VARIABLE SPEED SYSTEMS	9

Need of variable speed systems-Power-wind speed characteristics-Variable speed constantfrequencysystems synchronous generator-DFIG-PMSG Variablespeedgeneratorsmodeling-Variablespeedvariablefrequencyschemes.

UNIT V	GRID CONNECTED SYSTEMS	9

Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, andsupply of ancillary services for frequency and voltage control, current practices and industrytrends wind interconnection impact on steady-state and dynamic performance of the powersystem including modeling issue.

TOTAL PERIODS: 45

TEXT BOOKS

1.	L.L.Freris'Wind Energy conversion Systems', PrenticeHall,1990.
2.	N.Bhadra, D.Kastha, S.Banerjee,'Wind Electrical Systems', Oxford UniversityPress,2010.

REFERENCE BOOKS

1.	Gilbert Masters, 'Renewable and Efficient Electric Power Systems', Wiley 2004.
2.	Ion Boldea,'Variable speed generators', Taylor and Francis group,2006.
3.	N. Jenkins,'Wind Energy Technology' JohnWiley and Sons,1997
4.	S.Heir'Grid Integration of WECS', Wiley 1998.
5.	E.W.Golding'The generation of Electricity by wind power', Redwood burnLtd.,Trow bridge,1976.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Acquire knowledge on the basic concepts of Wind energy conversion system.	3
2	Understand the mathematical modeling and control of the wind turbine.	3
3	Develop a better understanding of the design of a fixed-speed system.	3
4	Understand the need for variable-speed systems and their modeling.	3
5	Learn about grid integration issues and current practices for wind interconnections with power systems.	3
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3		2	3			2		2	1	3
2	3	3	3	3		2	3			2		2	1	3
3	3	3	3	3		2	3			2		2	1	3
4	3	3	3	3		2	3			2		2	1	3
5	3	3	3	3		2	3			2		2	1	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22054	HYBRID RENEWABLE SYSTEM AND STORAGE TECHNOLOGIES	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Educate the fundamental concepts about different types of hybrid energy systems.
- Infer the various electrical Generators used for the Wind Energy Conversion Systems.
- To design the power converters used in Solar PV Systems.
- Understand the various power converters used in hybrid energy systems and to understand the importance of standalone and grid-connected operation in Hybrid renewable energy systems.
- To analyze the performance of the various hybrid energy systems.

UNIT I	INTRODUCTION TO HYBRID ENERGY SYSTEMS	9

Hybrid Energy Systems –Solar-Wind-Fuel Cell-Diesel, Wind Biomass-Diesel, Micro Hydro-PV, Ocean and geyser energy - Impacts of renewable energy generation on the environment - Present Indian and international energy scenario of conventional and RE sources - Solar Photovoltaic (PV) and Fuel cells.

UNIT II	ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS	9

Review of reference theory fundamentals –Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) - Permanent Magnet Synchronous Generator (PMSG).

UNIT III	POWER CONVERTERS AND ANALYSIS OF SOLAR PV SYSTEMS	9

Power Converters for SPV Systems - Line commutated converters (inversion-mode) - Boost and buck boost converters- selection of inverter, battery sizing, array sizing - Analysis of SPV Systems - Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems.

UNIT IV	ANALYSIS OF POWER CONVERTERS FOR HYBRID ENERGY SYSTEMS	9

Introduction to Power Converters – Stand-alone Converters -AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters - Bi-Directional Converters - Grid-Interactive Inverters - Matrix converter – Merits and Limitations.

UNIT V	ENERGY STORAGE SYSTEMS	9

Introduction to Electrical Energy Storage: Fuel Cell, Batteries, Flywheel, Super capacitors, Compressed air energy storage, Pumped Hydro Storage, Thermal Storage System.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Md. Rabiul Islam, Md. Rakibuzzaman Shah, Mohd Hasan Ali, 'Emerging Power Converters for Renewable Energy and Electric Vehicles', CRC Press, 2021, 1st Edition.
2.	Bahman Zohuri, 'Hybrid Energy Systems', Springer, 2018, 1st Edition.

REFERENCE BOOKS

1.	Ibrahim Dincer and Mark A. Rosen, 'Thermal Energy Storage Systems and Applications', John Wiley and Sons, 2021, 3rd Edition.
2.	S.M. Muyeen, 'Wind Energy Conversion Systems', 2012, Springer 1st Edition.
3.	James Larminie and Andrew Dicks, 'Fuel cell systems Explained', Wiley publications,2018, 3rdEdition.
4.	Ernst Joshua, 'Wind Energy Technology', PHI, India, 2018, 3rd Edition.
5.	S.N.Bhadra, D. Kastha, and S. Banerjee 'Wind Electrical Systems', Oxford University Press, 7th Impression, 2005.

6.	Rashid.M. H 'Power electronics Hand book', Academic press,2018, 4thEdition.
7.	Rai. G.D, 'Non-conventional energy sources', Khanna publishers, 6th Edition, 2017.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Analyze on the various Hybrid renewable energy systems and to study the present Indian and International energy scenario.	4
2	Validating the operation of various generators for WECS.	5
3	Examine the various converters for Solar PV System.	4
4	Investigate on the various power converters for hybrid energy systems.	4
5	Understand on the various Energy storage systems	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	3	3	1	3	3	1	1	2	3	3	3	3
2	3	2	3	3	2	3	3	1	1	2	3	3	3	3
3	3	2	3	3	2	3	3	1	1	2	3	3	3	3
4	3	2	3	3	2	3	3	1	1	2	3	3	3	3
5	3	1	3	2	1	3	3	1	1	2	3	3	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22055	POWER QUALITY	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand the various power quality issues
- To learn the voltage sag, swell and interruptions
- To explore the various harmonic issues
- To study the power quality monitoring
- To understand the power quality mitigation methods

UNIT I	INTRODUCTION TO POWER QUALITY	9

Terms and definitions – Overloading, under voltage, over voltage - Concepts of transients - Short duration variations such as interruption - Long duration variation such as sustained interruption - Voltage sag - Voltage swell - Voltage imbalance – Voltage fluctuation - Power frequency variations - International standards of power quality – Computer Business Equipment Manufacturers Associations (CBEMA) curve.

UNIT II	VOLTAGE SAGS AND INTERRUPTIONS	9

Sources of sags and interruptions - Estimating voltage sag performance - Thevenin's equivalent source - Analysis and calculation of various faulted condition - Voltage sag due to induction motor starting - Estimation of the sag severity - Mitigation of voltage sags, active series compensators - Static transfer switches and fast transfer switches.

UNIT III	OVERVOLTAGES & HARMONICS	9

Sources of over voltages - Capacitor switching – Lightning - Ferro resonance - Mitigation of voltage swells - Surge arresters - Low pass filters - Power conditioners - Lightning protection – Shielding - Line arresters - Protection of transformers and cables - Harmonics Vs transients. Effect of harmonics – Harmonic distortion - Voltage and current distortion - Harmonic indices - Devices for controlling harmonic distortion - Passive and active filters.

UNIT IV	POWER QUALITY MONITORING	9

Monitoring considerations - Monitoring and diagnostic techniques for various power quality problems - Modeling of power quality (harmonics and voltage sag) problems by mathematical simulation tools - Power line disturbance analyzer – Quality measurement equipment - Harmonic / spectrum analyzer - Flicker meters - Disturbance analyzer.

UNIT V	POWER QUALITY MITIGATION	9

Conventional load Compensation methods: Harmonic reduction and Voltage Sag reduction – Analysis of Unbalance – Load compensation using DSTATCOM: Ideal 3-phase Shunt Compensation structure, Reference current generation, realization and control of DSTATCOM – Introduction to series compensation using DVR.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Roger. C. Dugan, Mark. F. McGranaghan, Surya Santoso, H.Wayne Beaty, 'Electrical Power Systems Quality', McGraw Hill,2003.
2.	J. Arrillaga, N.R. Watson, S. Chen, 'Power System Quality Assessment', New York: Wiley, 1999.

REFERENCE BOOKS

1.	G.T. Heydt, 'Electric Power Quality', West Lafayette, IN, Stars in a Circle Publications, 1994, 2nd Edition.
2.	Arindham Ghosh, GerardLedwich,'Power Quality Enhancement using custom Power

	Devices', Kluwer Academic Publishers,2002
3.	M.H.J Bollen, 'Understanding Power Quality Problems: Voltage Sags and Interruptions', New York: IEEE Press, 1999.
4.	Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, 'Power Quality Problems and Mitigation Techniques' New York: Wiley, Reprint 2015.
5.	C. Sankaran, 'Power Quality', CRC Press 2001.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Comprehend the basics of power quality issues and their standards	3
2	Recognize the ideas behind voltage sag and swell issues.	3
3	Realize the harmonic difficulties and understand the enhancement strategies.	4
4	Examine the power quality issues and comprehend the monitoring devices.	4
5	Analyze mitigation approaches, including traditional compensation as well as contemporary techniques like as DSTATCOM and DVR.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3		2							3	2	3
2	3	3	3	2								3	2	3
3	3	3	3	2		2	2					3	2	3
4	3	3	3	3	3	2	2		2	2	2	3	2	3
5	3	3	3	3	3	2	2				2	3	2	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22056	ELECTRICAL SAFETY	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To outline the various electrical hazards and maintenance.
- To utilize the various safety equipment for electrical accidentfree environments.
- To demonstrate the safety procedures and first aid for the victims.
- To illustrate the safety procedures for residential and domestic installations.
- To provide protection for machines and operation of various fire extinguishers.

UNIT I	ELECTRICAL HAZARDS	9

The importance of Electrical Safety, Basic rules of Electrical Safety, The Electric circuit, Hazardous Electrical Locations, Electric Shock, Electrical Burns, Electrical fires and Electric Arc. Common types of electrical hazards. Maintenance of overhead and underground cable electric lines.

UNIT II	ELECTRICAL SAFETY EQUIPMENT	9

Work cloths, Personal Protective Equipment (PPE), Special body protection, Foot Protection, Gloves, Head protection, Eye Protection, Face protection, Safety harnesses and lifelines, Respiratory protection, Lockout devices, Barricade tape, Electrical tools, Voltage testers.

UNIT III	ELECTRICAL SAFETY PROCEDURES	9

Energy control, Electrical safety lockout, OSHA lockout procedures, Usage of power tools safely, Recognizing electric shock victims, First aid for shock victims, the basics lifesaving procedures using CPR, Electrical safety control measures.

UNIT IV	ELECTRICAL SAFETY IN RESIDENTIAL, COMMERCIAL AND AGRICULTURAL INSTALLATIONS	9

Wiring and fitting –Domestic appliances –water tap giving shock –shock from wet wall –fan firing shock – multi-storied building –Temporary installations – Agricultural pump installation –Do's and Don'ts for safety in the use of domestic electrical appliances. Grounding, grounding faults and short circuits.

UNIT V	MOTOR PROTECTION AND FIRE PREVENTION	9

Motor-Feeder protection, over current protection: Fuses, Circuit breakers and Relays, Single phasing, Fundamentals of fire-initiation of fires, types; extinguishing techniques, prevention of fire, types of fire extinguishers, fire detection and alarm system; CO2 and Halogen gas schemes; foam schemes.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Rao, S. and Saluja, H.L., 'Electrical Safety, Fire Safety Engineering and SafetyManagement', Khanna Publishers, 1988.
2.	STT205-ElectricalSafety.pdf (lsu.edu)

REFERENCE BOOKS

1.	Cooper.W.F, 'Electrical safety Engineering', Newnes-Butterworth Company, 1978.
2.	John Codick, 'Electrical safety hand book', McGraw Hill Inc., New Delhi, 2000.
3.	Nagrath, I.J. and Kothari, D.P., 'Power System Engineering', Tata McGraw Hill, 1998.
4.	Wadhwa, C.L., 'Electric Power Systems', New Age International, 2004
5.	'The Indian Electricity rules, 1956'(dgms.net)'

COURSE OUTCOMES		
Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Organize the objectives and precautions of Electrical safety, effects of shocks and their Prevention.	3
2	Articulate the various safety equipment and its purpose.	3
3	Categorization of electrical hazards and safety procedures.	4
4	Illustrate the electrical safety in residential, commercial and agricultural installations.	4
5	Examine the various motor protection and fire prevention methods.	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	3	3	3	3	3	3	3	3	3	1	3
2	3	3	2	3	3	3	3	3	3	3	3	3	1	3
3	3	3	2	3	3	3	3	3	3	3	3	3	1	3
4	3	3	2	3	3	3	3	3	3	3	3	3	1	3
5	3	3	2	3	3	3	3	3	3	3	3	3	1	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22057	ENERGY MANAGEMENT AND AUDITING	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand the concepts behind energy management and energy audit
- To learn the basics of materials and energy balance.
- To study the energy efficiency in lighting systems
- To emphasize the energy management on various electrical equipment and metering
- To explore the energy management in various electric utilities

UNIT I	GENERAL ASPECTS OF ENERGY MANAGEMENT AND ENERGY AUDIT	9

Commercial and Non-commercial energy - final energy consumption - energy needs of growing economy - energy pricing - energy conservation and its importance - Re-structuring of the energy supply sector - Energy Conservation Act 2001, Energy Conservation (Amendment) Act, 2010, and its features - electricity tariff - Thermal Basics - need and types of energy audit - Energy management/audit approach-understanding energy costs - maximizing system efficiencies - optimizing the input energy requirements - energy audit instruments - Case study of energy conservation and audit.

UNIT II	MATERIAL AND ENERGY BALANCE	9

Methods for preparing process flow - material and energy balance diagrams - Energy policy purpose - location of energy management - roles and responsibilities of energy manager – employees training and planning- Financial Management: financial analysis techniques, simple payback period, return on investment, net present value, internal rate of return – Case Study.

UNIT III	LIGHTING SYSTEMS AND COGENERATION	9

Lighting System: the task and the working space- Light source, Ballasts - Luminaries -choice of lighting, luminance requirements – occupancy sensors - energy efficient lighting controls - Optimizing lighting energy - Cost analysis techniques-Lighting and energy standards- Cogeneration: Forms of cogeneration - feasibility of cogeneration- Electrical interconnection- Case study of illumination system.

UNIT IV	METERING FOR ENERGY MANAGEMENT	9

Relationships between parameters-Units of measure-Typical cost factors- Utility meters - Timing of meter disc for kilowatt measurement - Demand meters - Paralleling of current transformers - Instrument transformer burdens-Multitasking solid-state meters - Metering location vs requirements- Metering techniques and practical examples.

UNIT V	ENERGY MANAGEMENTIN ELECTRICAL UTILITIES	9

Electrical load management and maximum demand control - power factor improvement and its benefit - selection and location of capacitors - performance assessment of PF capacitors - automatic power factor controllers - transformer losses - losses in induction motors - factors affecting motor performance - rewinding and motor replacement issues - soft starters with energy saver - variable speed drives – Fans and blowers: Types - efficient system operation - flow control strategies -Pumps and Pumping System: system operation - flow control methods - case study.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Mehmet Kanoglu, Yunus A Cengel, 'Energy Efficiency and Management for Engineers', McGrawHill Education, 2020, 1st Edition.
2.	Moncef Krati, 'Energy Audit of Building Systems: An Engineering Approach', CRC Press, Dec.2020, 3rd Edition.

REFERENCE BOOKS	
1.	Sonal Desai, 'Handbook of Energy Audit', McGraw Hill Education (India) Private Limited, 2015.
2.	Thomas D.Eastop, 'Energy Efficiency: For Engineers and Technologists', Longman Scientific and Technical, 1990, 1st Edition.
3.	Larry C. Witte, Philip S.Schmidt, David R.Brown, 'Industrial Energy Management and Utilization', Springer Berlin Heidelberg, 1988.
4.	L Ashok Kumar, Gokul Ganesan, 'Energy Audit and Management Concept, Methodologies, Procedures, and Case Studies', CRC Press, 2022, 1st Edition.
5.	https://beeindia.gov.in/en/energy-auditors.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Acquired expertise in energy management and audits	3
2	Recognize the fundamentals of economic analysis, material and energy balances	3
3	Realize the design of energy-efficient lighting system and the concept of cogeneration	4
4	Examine the various energy management metering systems	4
5	Analyze energy management in electrical utilities.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3	3			2				3		3
2	3	3	3	3								3		3
3	3	3	3	3		2	2				2	3		3
4	3	3	3	3		2		2			2	3		3
5	3	3	3	3		2	2	2			2	3		3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22058	ELECTRICAL ENERGY CONSERVATION AND UTILIZATION	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand the various electric drives and traction motors with applications
- To introduce the energy saving concept by different ways of illumination
- To comprehend the various electric welding and heating techniques
- To emphasize the energy conservation and its importance
- To investigate the residential use of electrical energy.

UNIT I	ELECTRIC DRIVES AND TRACTION	9

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

UNIT II	ILLUMINATION	9

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

UNIT III	HEATING AND WELDING	9

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

UNIT IV	ENERGY CONSERVATION AND ITS IMPORTANCE	9

Energy conservation act 2001 and its Features-Review of Industrial Energy Conservation-Energy conservation in electrical Industries-Simulation study of energy conservation using power factor controller. (Three phase circuit simulation with and without capacitor)- case study of energy conservation.

UNIT V	DOMESTIC UTILIATION OF ELECTRICAL ENERGY	9

House wiring - working principle of air conditioning system, Induction based appliances, Online and Offline UPS, Batteries - Power quality aspects – nonlinear and domestic loads – Earthing system for Domestic, Industrial and Substation.

TOTAL PERIODS: 45

TEXT BOOKS

1.	N.V. Suryanarayana, 'Utilisation of Electric Power', Wiley Eastern Limited, New Age International Limited, 1994.
2.	J.B.Gupta, 'Utilisation Electric power and Electric Traction', S.K.Kataria and sons, 2000.

REFERENCE BOOKS

1.	R.K.Rajput, 'Utilisation of Electric Power', Laxmi publications 2016, 2nd Edition.
2.	H.Partab, 'Art and Science of Utilisation of Electrical Energy', Dhanpat Rai and Co., New Delhi 2004.
3.	C.L.Wadhwa, 'Generation, Distribution and Utilisation of Electrical Energy', New Age international Pvt.Ltd., 2015, 3rd Edition.
4.	D.P.Kothari, K.C.Singal, Rakesh Ranjan, 'Renewable Energy Sources and Emerging Technologies', PHI Learing Private Limited, 2022, 3rd Edition.
5.	G.D.Rai,'Non-Conventional Energy sources',Khanna publications Ltd.,New Delhi 1998.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to:		
COs	**STATEMENTS**	**RBT LEVEL**
1	Acquired knowledge to choose suitable electric drives for different applications	4
2	Capable of developing energy-efficient illumination systems	4
3	Ability to demonstrate the utilization of electrical energy for heating and welding purposes	3
4	Analyze the necessity for energy conservation and its importance	4
5	Ability to do electric connection for any domestic appliance like refrigerator, battery charging circuit for a specific household application.	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3		2	2					3	3	3
2	3	3	3	3	2	2	2		2			3	3	3
3	3	3	3	3		2						3	3	3
4	3	3	3	3	2	2	2	2	2			3	3	3
5	3	3	3	3	2	2	2					3	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22050	RENEWABLE ENERGY SYSTEM LABORATORY	L T P C
		0 0 4 2

COURSE OBJECTIVES:

- Introduce students to the functionality and mechanics of diverse renewable energy systems while providing them with proficiency in design and modeling techniques.
- Study the performance of various renewable energy sources.
- Obtain hands-on experience on various wind turbine operation.
- To design and model PV system integration with grid.

LIST OF EXPERIMENTS	
1.	Simulation study on solar PV Energy System.
2.	Experiment on performance assessment of grid connected and standalone 1kWp Solar PV System.
3.	Simulation of wind energy conversion systems.
4.	Modelling and Performance evaluation of Fixed and variable speed WTGs.
5.	Experiment on performance assessment of micro wind energy generator.
6.	Simulation study on Stand-Alone hybrid wind-solar generation system.
7.	Experiment on performance assessment of Hybrid wind-solar power system.
8.	Modelling and analysis of Fuel cell system using MATLAB.
9.	Experiment on performance assessment of 100W Fuel Cell.
10.	Electrical Characterization of solar cell and Photo detector using DC Probe Station.
11.	Electrical Characterization of Piezoelectricity and Thin film transistor.
12.	Study of Biogas Plant.
	TOTAL PERIODS:60

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Understand the characteristics of various renewable energy sources.	4
2	Examine various MPPT algorithms and understand their merits and demerits.	4
3	Design and model PV system integration with grid.	4
4	Adaptability and efficiency of renewable energy devices.	4
5	Implement and verify control strategies for renewable energy applications.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3	3	3	3	3	2	2	3	3	3	3
2	3	3	3	3	3	3	3	3	2	2	3	3	3	3
3	3	3	3	3	3	3	3	3	2	1	3	3	3	3
4	3	3	3	3	3	3	3	3	2	1	3	3	3	3
5	3	3	3	3	3	3	3	3	2	1	3	3	3	3
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														

LABORATORY REQUIREMENTS FOR A BATCH OF 30 STUDENTS		
SL.NO	**DESCRIPTION OF EQUIPMENTS**	**QUANTITY REQUIRED**
1.	MATLAB, PSCAD, ETAP	As Required
2.	Operational amplifiers, Capacitors, Resistors, Variable resistance (Pot), Connecting Wires, CRO/ DSO with probes, Bread board, DC Power supply unit, 30V DC Shunt Motor, Speed sensor.	As Required
3.	Micro Wind Energy Training System (LT-7003D).	1
4.	Fuel cell energy training system (LT-7001).	1
5.	Wind-Solar Hybrid Power System Trainer (LT-7003E).	1
6.	1KW solar PV system	1
7.	Power module, BLDC motor (0.5HP) Controller circuit, sensor circuit, display meter, DSO – 1 set	As Required
8.	DC probe station	1

VERTICAL VI: SEMICONDUCTOR TECHNOLOGY

EE22061	SOLID STATE DEVICES	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Understand the fundamental concepts of Quantum Mechanics
- Apply Fermi-Dirac probability function to study the characteristics of semiconductor in equilibrium
- Analyze excess charge carrier concentration in con-equilibrium condition.
- Acquire the knowledge on formation, working and characteristics PN junction
- Examine the conditions that yield metal-semiconductor ohmic/schotkky contacts.

UNIT I	INTRODUCTION TO QUANTUM THEORY OF SOLIDS	9

The Crystal Structure of Solids - Growth of Semiconductor Materials - Principles of Quantum Mechanics– Schrodinger's Wave Equation and its application– Extensions of Wave Theory to Atoms – Allowed and forbidden Energy bands–Electrical Conduction in solids– Density of State functions.

UNIT II	SEMICONDUCTORS IN EQUILIBRIUM	9

Charge Carriers in Semiconductors–Dopant atoms and Energy Levels–Dopant Atoms and Energy levels-Extrinsic Semiconductor–Statistics of Donors and Acceptors– Charge Neutrality–Position of Fermi Energy Levels.

UNIT III	CARRIER TRANSPORT	9

Carrier Drift– Carrier Diffusion–Graded Impurity Distribution– Hall Effect–Carrier Generation and Recombination–Characteristics of Excess Carrier–Amipolar Transport –Quasi –Fermi Levels–Excess Carrier Lifetime.

UNIT IV	PN JUNCTIONS	9

Basic Structure of the PN Junctions – PN Junction Under Zero Applied Bias, Forward Bias and Reverse Bias–Junction Capacitance–One sided pn Junction–Non-uniformly Doped Junctions-PN junction current – Small signal model of the pn Junction – Diode current equation – Junction Breakdown -Charge Storage and Diode Transients

UNIT V	METAL-SEMICONDUCTOR AND SEMICONDUCTOR HETEROJUNCTIONS	9

The Schottky Barrier Diode - Comparison of Schottky Barrier Diode and the pn Junction Diode. - Metal-Semiconductor Ohmic Contacts - Heterojunctions

TOTAL PERIODS: 45

TEXT BOOKS

1.	Semiconductor Physics and Devices", Donald.A.Neamen, McGraw Hill,2012, 4th Edition.
2.	Solid State Electronic Devices, B.G. Streetman and S. Banerjee, PHI Learning, 2009, 6th edition.

REFERENCE BOOKS

1.	Semiconductor Devices Modelling and Technology, Nandita Das Gupta, Amitava Das Gupta, Prentice Hall of India Private Ltd, 2011
2.	Semiconductor devices: Physics and Technology, S.M. Sze, Wiley, 2008, 2nd Edition.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to:		
COs	**STATEMENTS**	**RBT LEVEL**
1	Understand the principles of quantum mechanics in semiconductors.	4
2	Apply Fermi-Dirac probability function and determine carrier concentrations in thermal equilibrium.	4
3	Apply generation and recombination in semiconductors, thereby analyse electrical characteristics in non-equilibrium condition.	4
4	Derive space charge region characteristics, built-in potential barrier voltage and junction capacitance in a PN junction.	4
5	Analyze the behaviour of metal-semiconductor junction for ohmic and schotkky contacts	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3						2	2				3
2	3	3	3	3					2	2				3
3	3	3	3	3					2	2				3
4	3	3	3	3	3				2	2				3
5	2	3	3	3					2	2		3		3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22062	MICROELECTRONIC CIRCUITS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To acquire knowledge on semiconductor physics and its evolutions in device characteristics.
- To implement any analog, digital or mixed signal circuits using semiconductor devices.

UNIT I	PN JUNCTION AND ITS APPLICATION	9

Energy band theory of crystal–Classification of semiconductors–charge carriers–carrier transport–Generation and recombination. PN Junctions: Equilibrium Analysis–Ideal diode–Carrier Transport Under Applied Bias – Junction Capacitance– Diode Circuit Models. Applications of PN Junction –Rectifiers–LEDs– Detectors–Limiting and clamping circuits–Digital logic gates

UNIT II	BIPOLAR JUNCTION TRANSISTOR	9

Device structure and Physical operation– Current –Voltage characteristics –Non ideal effects– The BJT as a amplifier and switch–Small signal operation and Models

UNIT III	MOS FIELD EFFECT TRANSISTOR	9

Two terminal MOS structure–Energy band diagrams–Depletion layer thickness–work function differences–Flat–band voltage–Threshold voltage–Charge distribution–Capacitance–Voltage characteristics. MOSFET operation–Current–Voltage characteristics–Velocity saturation – Channel Length Modulation–Circuit Models

UNIT IV	ANALOG CIRCUITS	9

IC Biasing- Current source, Current mirrors and Current steering circuits- Basic Gain Cell – The common gate and common base amplifiers- Cascode Amplifier – Current mirror circuits with improved performance.

UNIT V	DIGITAL CIRCUITS	9

Inverter Characteristics and Circuits– Gates (AND/NAND, OR/NOR) CMOS Inverters and Gates–Switching transients and gate delays. Simple CMOS implementation of logic circuits.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Adel S.Sedra, Kenneth.C.Smith, 'Microelectronic Circuits', Oxford University Press, 2016, 7th Edition.
2.	Donald.A.Neamen, "Semiconductor Physics and Devices", McGrawHill, 2012, 4thEdition,.

REFERENCE BOOKS

1.	B.G. Streetman and S. Banerjee, 'Solid State Electronic Devices', PHI Learning, 2009, 6thEdition.
2.	Richard Muller, Theodore.I.Kamins, Mansun Chan, 'Device Electronics for Integrated Circuits', John Wiley,2003, 3rdEdition,.
3.	M. S. Tyagi, 'Introduction to Semiconductor Materials and Devices', John Wiley, 2004

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to:		
COs	**STATEMENTS**	**RBT LEVEL**
1	Understand the transport behavior of the semiconductor devices.	4
2	Analyze the characteristics of a Bipolar junction transistor.	4
3	Analyze the characteristics of MOS device.	4
4	Design and analyze any analog circuit using BJT and MOS devices.	4
5	Design and analyze any digital circuit using CMOS devices.	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3						2	2				3
2	3	3	3	3					2	2				3
3	3	3	3	3					2	2				3
4	3	3	3	3					2	2				3
5	3	3	3	3					2	2		3		3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22063	SEMICONDUCTOR TECHNOLOGY	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Explore the evolution of Nanotechnology in various fields of engineering.
- Learn the details of clean room environment and Safety Hazards.
- Understand various preparation methods of nano systems and nanofabrication techniques.
- Investigate different characterization techniques used for Nano systems

UNIT I	INTRODUCTION TO NANOTECHNOLOGY	9

Introduction to Nano Technology— Historical Development—Surface to volume ratio—Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of Nanomaterials – Classifications of nanomaterials based on dimensionality.

UNIT II	SEMICONDUCTOR PROCESSING AND MICROFABRICATION	9

Introduction to semiconductor processing – Necessity for a clean room– Classification of clean rooms Structure and requirements of a clean room– Safety issues, flammable and toxic hazards, biohazards – Microfabrication process flow using block diagram approach.

UNIT III	SYNTHESIS OF MATERIALS	9

Preparation of nanoscale materials: Spray Pyrolysis, Co–Precipitation, Sol–gel, Mechanical Milling, Self–assembly, Preparation of thin films: Electroplating, Sputtering, Evaporation, MOCVD, Molecular Beam Epitaxy, Atomic Layer Epitaxy and Pulsed layer deposition.

UNIT IV	CHARACTERIZATION TECHNIQUES	9

X–ray diffraction technique, Scanning Electron Microscopy – environmental techniques, Transmission Electron Microscopy including high–resolution imaging, Surface Analysis Techniques – AFM, SPM, STM, SNOM, ESCA.

UNIT V	APPLICATIONS OF NANOTECHNOLOGY	9

Nano InfoTech: Information storage–nano computer, molecular switch, super chip, nanocrystal,Nano biotechnology: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging– Micro Electro Mechanical Systems (MEMS), NanoElectro Mechanical Systems (NEMS)–Nanosensors, nano crystalline silver for bacteria linhibition, Nanoparticles for sun barrier products – In Photostat, printing, solar cell, battery.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Chattopadhyay K.K and A.N Banerjee, 'Introduction to Nanoscience and nanotechnology', PHI, 2009.
2.	T. Pradeep, 'Nano: The Essentials understanding Nanoscience and Nanotechnology',TataMcGraw Hill Education, 2007.

REFERENCE BOOKS

1.	Fahrner W.R., 'Nanotechnology and Nanoelectronics', Springer (India) Private Ltd.,2011.
2.	Madou Marc J, 'Fundamentals of Microfabrication', CRC Press, New York, 1997

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to:		
COs	**STATEMENTS**	**RBT LEVEL**
1	Understand unique properties of Nano material structure and apply them for different Engineering fields.	3
2	Work in a safe environment following stringent safety protocol in Nano-fabrication cleanroom.	3
3	Synthesis different types of nanomaterials using various top-down and bottom-up approach.	4
4	Characterize different types of nano-particles and nano-devices using electrical, optical and structural methods	4
5	Comprehend varied applications of nanotechnology in sub-micron and nano-scale range.	3
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3						2	3				3
2	3	3	3		3	3		3	2	3				3
3	3	3	3	3	3			3	2	3		2		3
4	3	3	3	3	3			3	2	3		2		3
5	2	3	3	3			3	3	2	3		2		3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EC22504	PHYSICAL VLSI DESIGN	L T P C
	(COMMON TO EC AND EE)	3 0 0 3

COURSE OBJECTIVES:

- To understand the fabrication processes of MOS circuits, design rules for layouts and the limitations in scaling.
- To learn about realization of MOS circuits for various combinational logic blocks and analyze the performance trade-offs with respect to the area, power and delay.
- To study the various arithmetic building blocks and their timing constraints.
- To learn about the various synchronous and asynchronous sequential designs and analyze the timing constraints.
- To learn about the various architectural choices available for FPGA.

UNIT I	MOS TRANSISTOR PRINCIPLE	9

NMOS, PMOS -Enhancement and depletion MOSFET; MOS transistor-Ideal I-V characteristics; Fabrication Process - MOSFET, CMOS- n-well, p-well, Twin tub, SOI; Scaling principles and fundamental limits; CMOS inverter characteristics; Stick diagram; Layout diagrams; Design rules; Layer Representation.

UNIT II	COMBINATIONAL LOGIC CIRCUITS	9

Static CMOS Design: Examples of Combinational Logic Design; Complementary CMOS concept and properties; Ratioed Logic -DCVSL logic gate; Pass Transistor Logic - Concept, Complementary PTL and Differential PTL; CMOS transmission gate; Elmore's constant; Dynamic CMOS design: Dynamic Logic - Basic Principles; Issues in Dynamic Design; Cascading Dynamic Gates.

UNIT III	SEQUENTIAL LOGIC CIRCUITS	9

Timing Metrics for Sequential Circuits; Static Latches and Registers; Bi-stability Principle; Multiplexer Based Latches; Master-Slave based Edge Triggered Register; Non-ideal clock signals; Dynamic Latches and Registers; Transmission-Gate Edge-triggered Registers; C^2MOS Register; Dual-Edge Registers; Timing issues; Pipelines; Clock Strategies; Synchronous and Asynchronous design. Introduction to Memory.

UNIT IV	DESIGNING ARITHMETIC BUILDING BLOCKS	9

Data path circuits: Architectures for Ripple Carry Adders; Carry Look Ahead Adders; Carry Select Adder; Carry Bypass Adder; High speed adders - Brunt Kung adder, Kogge Stone; Multipliers - Wallace Tree multiplier, Booth Multiplier; Barrel shifters; Speed and Area Trade-off for all above Arithmetic Building Blocks.

UNIT V	IMPLEMENTATION STRATEGIES	9

Full custom and Semi-custom design; Standard cell design and cell libraries; FPGA building block architecture - FPGA interconnect routing procedures; Design for Testability: Ad Hoc Testing, Scan Design, BIST. Low power design principles.

TOTAL: 45 PERIODS

TEXT BOOKS

1	Jan M.Rabaey, Anantha Chandrakasan, Borivoje Nikolic, 'Digital Integrated Circuits: A DesignPerspective', Prentice Hall of India, 2008, 3rd Edition,.
2	M.J. Smith, 'Application Specific Integrated Circuits', Addisson Wesley, 1997.

REFERENCE BOOKS

1	N.Weste, K.Eshraghian, 'Principles of CMOS VLSI Design', Addision Wesley 1993, 2nd Edition,.
2	R.Jacob Baker, Harry W.LI., David E.Boyee, 'CMOS Circuit Design, Layout and Simulation', Prentice Hall of India 2005.
3	A.Pucknell, Kamran Eshraghian, 'Basic VLSI Design', Prentice Hall of India, 2007, 3rd Edition,.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to:		
COs	**STATEMENTS**	**RBT LEVEL**
1	Represent the CMOS logic circuit design using Stick Diagrams and Layout Diagrams.	3
2	Realize the MOS circuits for various combinational logic blocks.	4
3	Choose a suitable MOS logic style for designing Sequential logic blocks.	4
4	Select suitable MOS logic style for designing Sequential logic blocks.	4
5	Choose a suitable FPGA implementation strategy.	3
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3		2	3							2	3	3
2	3	2	1	3	3		2					2	3	3
3	3	2	1	3	3		2					2	3	3
4	3	2	1	3	3							2	3	3
5	3	2		2	3							2	3	1

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22064	MEMS TECHNOLOGY	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Impart knowledge on the properties of materials, microstructure, micromachining and fabrication.
- Design and model various MEMS based sensors and actuators

UNIT I	INTRODUCTION	9

Introduction to Micro electro mechanical systems - Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – Packaging and Integration- MEMS Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor conductivity and resistivity – Stress and strain analysis – Flexural beam bending- Torsional deflection - Fabrication of a micro-heater.

UNIT II	SENSORS AND ACTUATORS-I	9

Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Combdrive devices – Micro Grippers – Micro Motors

UNIT III	SENSORS AND ACTUATORS-II	9

Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications – Magnetic Actuators – Micromagnetic components – Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys.

UNIT IV	SENSORS AND ACTUATORS-III	9

Piezoresistive sensors – Piezoresistive sensor materials - Stress analysis of mechanical elementsApplications to Inertia, Pressure, Tactile and Flow sensors – Case Study: Novasensor BP sensor.

UNIT V	SENSORS AND ACTUATORS-IV	9

Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – Applications to Inertia, Acoustic, Tactile and Flow sensors - Optical MEMS – Texas Digital Light Processor

TOTAL PERIODS: 45

TEXT BOOKS

1.	Chang Liu, ‘Foundations of MEMS’, Pearson Education Inc., 2012.

REFERENCE BOOKS

1.	Marc Madou, ‘Fundamentals of microfabrication’,CRC Press, 1997.
2.	Boston, ‘Micromachined Transducers Source book’,WCB McGraw Hill, 1998.
3.	M.H.Bao, ‘Micromechanical transducers :Pressure sensors, accelerometers and gyroscopes’, Elsevier, Newyork, 2000.
4	P. Rai Choudry, ‘MEMS and MOEMS Technology and Applications’, PHI, 2012

COURSE OUTCOMES		
Upon the successful completion of the course, the students will be able to:		
COs	**STATEMENTS**	**RBT LEVEL**
1	Acquire knowledge of materials, microstructure and fabrication techniques	4
2	Design and analyze electrostatic MEMS devices	4
3	Design and analyze thermal based MEMS devices	4
4	Design and analyze Piezoresistive MEMS devices	4
5	Design and analyze Piezoelectric MEMS devices	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3						2	2				3
2	3	3	3	3					2	2				3
3	3	3	3	3					2	2				3
4	3	3	3	3					2	2				3
5	3	3	3	3					2	2				3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22065	WIDE BANDGAP SEMICONDUCTORS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Introduce the concept of wide band gap (WBG) devices and its application in real world
- Advantages and disadvantages of WBG devices
- Provide an introduction to basic operation of WBG power devices
- Learn Design principles of modern power devices
- Ability to deal high frequency design complexity

UNIT I	WBG DEVICES AND THEIR APPLICATION IN REAL WORLD	9

Review of semiconductor basics, Operation and characteristics of the SiC Schottky Barrier Diode,SiC DMOSFET and GaN HEMT, Review of Wide bandgap semiconductor technology -Advantagesand disadvantages - Material Properties of Si and wide band gap semiconductors.

UNIT II	SWITCHING CHARACTERIZATION OF WBG	9

Turn-on and Turn-off characteristics of the device, Hard switching loss analysis, Double pulse test set-up.

UNIT III	DRIVERS FOR WIDE BAND GAP DEVICES	9

Gate driver, Impact of gate resistance, Gate drivers for wide bandgap power devices, Transient immunity integrated gate drivers.

UNIT IV	HIGH FREQUENCY DESIGN COMPLEXITY AND PCB DESIGNING	9

Effects of parasitic inductance, Effects of parasitic capacitance, EMI filter design for high frequency power converters High frequency PCB design, Conventional power loop design, High frequency power loop optimization, Separation of power from signal PCB

UNIT V	APPLICATIONS OF WIDE BANDGAP DEVICES	9

Consumer electronics applications, Wireless power transfer applications, Electric vehicle applications, Renewable energy sources applications

TOTAL PERIODS: 45

TEXT BOOKS

1.	B.J.Baliga, 'Gallium Nitride and Silicon Carbide Power Devices,' World Scientific Publishing Company (2017).
2.	G. Meneghesso, M. Meneghini, E. Zanoni, 'Gallium Nitride-enabled High Frequency andHigh Efficiency Power Conversion,' Springer International Publishing, 2018, ISBN: 978-3-319-77993-5.

REFERENCE BOOKS

1.	F. Wang, Z. Zhang and E. A. Jones, 'Characterization of Wide Bandgap Power SemiconductorDevices', IET, ISBN-13: 978-1785614910 (2018).
2.	L. Corradini, D. Maksimovic, P. Mattavelli, R. Zane, 'Digital Control of High FrequencySwitched-Mode Power Converters', Wiley, ISBN-13: 978-1118935101 (2015).

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Master design principles of power devices	3
2	Become familiar with reliability issues and testing methods	3
3	Become competent with specifications of commercial power devices	4
4	Processing details of power devices	4
5	familiar with reliability issues and testing methods	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2	3	3					1	1	2		2		3
2	2	3	3					1	1	2		2		3
3	2	3	3	3				1	1	2		2		3
4	2	3	3					1	1	2		2		3
5	2	3	3			2	2	1	1	2		2		3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22066	SENSOR TECHNOLOGY	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To teach the fundamental principles underlying sensor technology.
- To familiarize students with various types of sensors and their applications.
- To develop skills in selecting appropriate sensors for specific applications.
- To provide practical experience in designing, calibrating, and integrating sensors into electronic systems.
- To promote rigorous thinking in emerging trends and advancements in sensor technology.

UNIT I	SENSORS FUNDAMENTALS AND CHARACTERISTICS	9

Importance of sensors in technology- Signals and Systems- Sensor Classification-Units of Measurements; Sensor Characteristics- accuracy, precision, resolution, and sensitivity-Sensor selection criteria and trade-offs –Various Types of Sensors and its working principles.

UNIT II	SENSING PRINCIPLES	9

Over view of various sensor types-Electric Charges, Fields, and Potentials-Capacitance- Magnetism-Induction- Resistance- Piezoelectric Effect- Hall Effect-Temperature and Thermal Properties of Material, Heat Transfer-Light-Dynamic Models of Sensor Elements

UNIT III	ELECTRONIC INTERFACE -SIGNAL CONDITIONING AND AMPLIFICATION	9

Introduction to test and measuring instruments, Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits, Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries for Low Power Sensors, Sensor calibration and techniques. Power management and energy efficiency considerations for sensor systems Noise reduction techniques and electromagnetic compatibility (EMC) consideration.

UNIT IV	SENSORS IN DIFFERENT APPLICATION AREA	9

Sensors in Health care and biomedical, Energy, environmental monitoring, and smart cities, Aerospace, Sensor applications in autonomous vehicles, driver assistance systems, and traffic monitoring and Defence and security. Case studies on real word applications.

Occupancy and Motion Detectors; Position, Displacement, and Level; Velocity and Acceleration; Force, Strain, and Tactile Sensors; Pressure Sensors, Temperature Sensors, Wearable sensors

UNIT V	EMERGING TRENDS IN SENSOR TECHNOLOGY	9

Sensor miniaturization and nanoscale fabrication techniques - PCB design considerations for sensor integration-Internet of Things (IoT) and sensor networks - Integration of sensors with AI, machine learning, and edge computing,

TOTAL PERIODS: 45

TEXT BOOKS

1.	J. Fraden, Handbook of Modern Sensors:Physical, Designs, and Applications, AIP Press, Springer, 2014.

REFERENCE BOOKS

1.	D. Patranabis, Sensors and Transducers, PHI Publication, New Delhi, 2003.
2.	Mechatronics- Ganesh S. Hegde, Published by University Science Press Laxmi Publications Pvt Limited, 2011

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to:		
COs	**STATEMENTS**	**RBT LEVEL**
1	Understand the fundamental concepts and determine the electrical characteristics of sensors.	4
2	Identify and select the sensors based the sensor operating principles	4
3	Design simple sensor circuits for signal conditioning, amplification, and interfacing data acquisition systems.	4
4	Analyze case studies to understand real-world applications of sensortechnologyin various fields.	4
5	Fabricate miniaturized sensors and integrate with AI, ML and edge computing modules.	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3						2	2				3
2	3	3	3	3					2	2				3
3	3	3	3	3			3		2	2				3
4	3	3	3	3		3	3		2	2				3
5	3	3	3	3	3				2	2		3		3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22067	EMBEDDED SYSTEM DESIGN	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand the building blocks of an embedded System and Software Tools.
- To emphasize the role of Input/output interfacing with Bus Communication protocol in embedded system.
- To acquire knowledge in architecture of ARM7 processor and its programming.
- To implement the interface of peripherals using communication protocols in LPC2148.
- To educate the RTOS concepts and study the embedded system design cycle.

UNIT I	INTRODUCTION TO EMBEDDED SYSTEMS	9

Introduction to Embedded Systems – Structural units in Embedded processor, selection of processor & memory devices, hardware units and software tools in embedded systems, Direct Memory Access – Memory management methods – Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging.

UNIT II	EMBEDDED NETWORKING PROTOCOLS	9

Embedded Networking: Introduction, I/O Device Ports & Buses – Serial Bus communication protocols: RS232 standard – RS422 – RS 485 – CAN Bus – Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I^2C) – Need for device drivers.

UNIT III	ARM PROCESSOR AND PROGRAMMING	9

ARM7 Processor - Introduction - RISC features - Levels in architecture, Functional description - processor and memory organization - Data alignment and byte ordering - ARM Instruction Set Architecture (ISA) - pipelining – Simple Assembly Language Programming – Architectural support: High Level Languages - System development – Operating systems.

UNIT IV	ARM7TDMI BASED SOC INTERFACE AND IMPLEMENTATION OF PROTOCOLS	9

LPC2148: Peripherals, Memory mapping for data, code and peripherals, pin configuration, pin connect block, GPIO Peripheral - Nested vectored interrupt controller & Interrupts in LPC2148 - ADC, DAC and RTC in LPC2148 - Timer in LPC2148 and its various modes of operations PC2148: UART, SPI and I2C protocol and its implementation in LPC2148.

UNIT V	RTOS AND EMBEDDED SYSTEM APPLICATION DEVELOPMENT	9

RTOS Introduction: RTOS Necessity - Operating system services - CPU metrics - RTOS Task scheduling models - OS security issues - Design cycle in the development phase for an embedded system - Issues in Embedded System Design.Case Study of Washing Machine- Automotive Application- Smart card System Application.

TOTAL PERIODS: 45

TEXT BOOKS

1. Rajkamal, 'Embedded system -Architecture, Programming, Design', McGraw-Hill Edu, 3rd Edition 2017
2. Muhammad TahirandKashifJaved, 'ARM Microprocessor Systems: Cortex-M Architecture, Programming, and Interfacing', CRC Press, 1st Edition, 2017

REFERENCE BOOKS

1. Lyla B Das,'Embedded Systems-An Integrated Approach', Pearson publication,2012, 1st Edition.
2. Wayne Wolf, 'Computers as Components: Principles of Embedded Computing System

	Design', Morgan Kaufman Publishers, 2008
3	Chattopadhyay and Santanu 'Embedded System Design' PHI publisher, 2022, 3rd Edition.
4.	A. P. Godse, 'ARM Controller: ARM Fundamentals, LPC2148 CPU and Peripherals', technical publisher, 2020

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Acquire knowledge about embedded system and selection of processors and memory.	5
2	Learn about the embedded networking protocols and its applications.	4
3	Understand the architecture of ARM processor and its programming	5
4	Acquire knowledge to interfacing of peripherals with ARM Processor.	3
5	Understand the concept of RTOS and embedded system development life cycle	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	3	3	2	2	3			2	3	2		3	2	3
2	3	3	2	2	3			2	3	2		3	2	3
3	3	3	2	2	3			2	3	2		3	2	3
4	3	3	2	2	3			2	3	2		3	2	3
5	3	3	3	2	3			2	3	2		3	2	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22060	IC DESIGN LABORATORY	L T P C
		0 0 4 2

COURSE OBJECTIVES

- To acquire skills in semiconductor device designing using software tool. (COMSOL)
- To expose the students to different wet and physical methods of material synthesis and develop experimental and data analysis skills.

LIST OF EXPERIMENTS	
1.	Introduction to NFF and Safety Training (nano fabrication facility)
2.	Standard Cleaning
3.	PCB Design using KICAD software Simulation
4.	Design of two terminal device using COMSOL MULTIPHYSICS
5.	Synthesis of two terminal device using chemical method
6.	Synthesis of two terminal device using physical method
7.	Nano/Micro Scale Pattern and Exposure using Photolithography
8.	Metallization using Thermal Evaporation
9.	Characterization of two terminal device
10.	Digital IC design
	TOTAL PERIODS: 60

REFERENCE BOOKS

1.	Marc Madou, 'Fundamentals of microfabrication', CRC Press, 1997.
2	S M SZE, 'Fundamental of Semiconductor Fabrication', 2010, 3rd Edition.

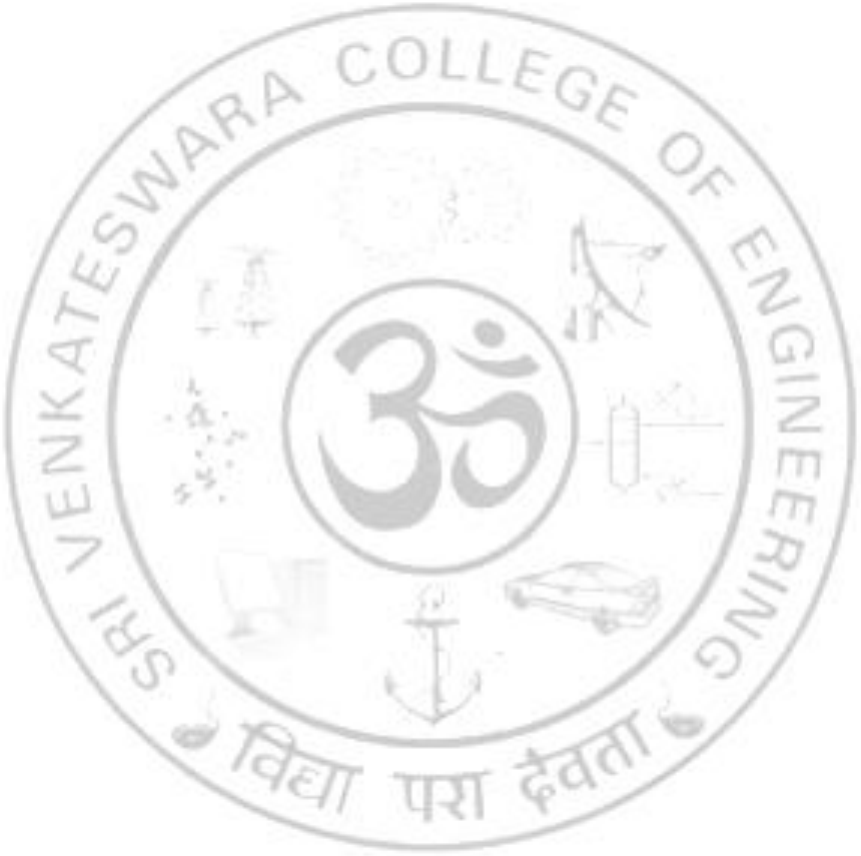
COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Understand the operation of a cleanroom and recognize the basic operation principles of semiconductor fabrication equipment	2
2	Identify the process modules available in IC fabrication	3
3	Evaluate effects of process parameters on final device /IC characteristics	4
4	Apply the measurement skills for microelectronic devices and IC characterization.	3
5	Design process flows of IC fabrication technologies	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3						2	2				3
2	3	3	3	3					2	2				3
3	3	3	3	3					2	2				3
4	3	3	3	3					2	2				3
5	3	3	3	3					2	2		3		3
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														



VERTICAL VII: DIVERSIFIED GROUP-I

EE22071	ANALOG AND DIGITAL CONTROLLERS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To provide an overview of the control system and converter control methodologies
- To provide an insight to the analog controllers generally used in practice
- To introduce Embedded Processors for Digital Control
- To study on the driving techniques, isolation requirements, signal conditioning and protection methods
- To provide a Case Study by implementing an analog and a digital controller on a converter

UNIT I	CONTROL SYSTEM - OVERVIEW	9

Feedback and Feed-forward control, Right Half Plane Zero, Gain margin and Phase Margin, Stability, Analysis and Transfer function of PI and PID controllers and its effects.

UNIT II	ANALOG CONTROLLERS	9

Major components of a controller - Op-Amp based PI and PID controller - Proportional, Integral and Differential gains in terms of Resistance and Capacitance, Error Amplifiers, PWM generator using Ramp or Triangular generator and comparator and Driver, Voltage mode controller design, Peak Current mode controller design.

UNIT III	DIGITAL CONTROLLERS	9

Micro Controllers and Digital Signal Controllers for Converter Control Application, Interface Modules for Converter Control - A/D, Capture, Compare and PWM- FPGA Controller, interrupts, Discrete PI and PID equations.

UNIT IV	SIGNAL CONDITIONING, DRIVER, ISOLATION AND PROTECTION	9

Voltage feedback sensing circuits, Hall effect sensors and Shunts for current feedback sensing, Low offset Op-Amps for signal conditioning, Single and dual supply op-amps, Totem pole drivers, Need for isolated drivers, optically isolated drivers, low side drivers, high side drivers with bootstrap power supply.

UNIT V	CONTROLLER IMPLEMENTATION	9

Analog and Digital Controller Design for Buck Converter - Power circuit transfer function and bode plot, PI controller bode plot, Implementation of Analog controller and Digital controller.

TOTAL PERIODS: 45

TEXT BOOKS

1.	I.J. Nagrath and M. Gopal, 'Control Systems Engineering', New Age International Publishers,2021
2.	Robert W. Erickson, Dragan Maksimović 'Fundamentals of Power Electronics', SpringerLink, 2020.

REFERENCE BOOKS

1.	Simon Ang, Alejandro Oliva,'Power-Switching Converters', CRC Press, 2011, 3rd Edition.
2.	Heinz Weihrich, Mark V Cannice, and Harold Koontz 'Management: A Global, Innovative and Entrepreneurial Perspective', McGrawHill, 2019, 15th Edition.
3.	Marian K. Kazimierczuk, 'Pulse-width Modulated DC-DC Power Converters', Publisher, WileyBlackwell, 2015, 2nd Edition.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Identify the effect of PID controllers in system stability.	4
2	Design and apply analog controllers for Industrial applications	4
3	Design and apply Digital controllers for digital applications.	4
4	Design suitable signal conditioning circuits and drivers for hardware.	4
5	Implement controller design in hardware converter circuits.	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3	2	2	1	1	1		2	2	3	2
2	3	3	3	3	2	2	1	1	1		2	2	3	2
3	3	3	3	3	2	2	1	1	1		2	2	3	2
4	3	3	3	3	3	2	1	1	1		2	2	3	2
5	3	3	3	3	3	2	1	1	1		2	2	3	

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22072	BIOMEDICAL INSTRUMENTATION	LT P C
		3 0 0 3

COURSE OBJECTIVES

- To introduce fundamentals of transducers as applicable to physiology
- To explore the human body parameter measurements setups
- To make the students understand the basic concepts of forensic techniques
- To familiarize the students with the measurement of vital body parameters
- To introduce the various medical imaging techniques

UNIT I	PHYSIOLOGY AND TRANSDUCERS	9

Cell and its structure - Resting and Action Potential - Nervous system - Neurons, synapse, transmitters and neural communication. Cardiovascular system - Respiratory system - Basic components of a biomedical system- Transducers - Selection criteria. Piezo-electric, ultrasonic transducers, temperature transducers - Fiber optic temperature sensors.

UNIT II	ELECTRICAL PARAMETER MEASUREMENTS	9

Introduction to polarizable and nonpolarizable electrodes – Types of Electrodes - Limb electrodes, floating electrodes, pre-gelled disposable electrodes, Micro, needle and surface electrodes - Amplifiers: Preamplifiers, differential amplifiers, chopper amplifiers, Isolation amplifier. ECG, EEG, EMG, ERG, Lead systems and recording methods, Typical waveforms. Electrical safety in medical environment: shock hazards, leakage current-Instruments for checking safety parameters of biomedical equipment.

UNIT III	NON-ELECTRICAL PARAMETER MEASUREMENTS	9

Measurement of blood pressure, Cardiac output, Heart rate, Heart sound, Pulmonary function measurements, Spirometer, Photo Plethysmography, Body Plethysmography, Blood Gas analyzers: pH of blood, measurement of blood pCO2, pO2, finger-tip oximeter, ESR, GSR, measurements, Standard HL7.

UNIT IV	MEDICAL IMAGING	9

Radiographic and fluoroscopic techniques, X rays, Computer tomography, Mammography, MRI, fMRI, Ultrasonography, Endoscopy, Thermography - Nuclear medicine and laser technology - Artificial intelligence and machine learning in medical imaging.

UNIT V	LIFE ASSISTING AND THERAPEUTIC EQUIPMENT	9

Pacemakers – Defibrillators - Ventilators - Nerve and muscle stimulators, Diathermy - Heart Lung machine - Audio meters - Dialyzers, Lithotripsy - Therapeutic Devices – Infant Incubators – Surgical Instruments – Nano Robots – Robotic surgery - Keyhole Surgery - Moral and ethical considerations, human and animal research, consent, and death.

TOTAL PERIODS: 45

TEXT BOOKS

1.	John G. Webster, 'Medical Instrumentation Application and Design', John Wiley and sons, New York, 2009, 4th Edition.
2.	R.S.Khandpur, 'Hand Book of Bio-Medical instrumentation', Tata McGraw Hill Publishing Co Ltd., 2003

REFERENCE BOOKS

1.	Arumugam M, 'Biomedical Instrumentation', Anuradha Agencies Publishers, Chennai, 2010.
2.	Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, 'Bio-Medical Instrumentation and Measurements', Pearson Education, 2002 / PHI, 2nd Edition.
3.	J.Webster, 'Medical Instrumentation', John Wiley & Sons, 1995.

4.	L.A. Geddes and L.E.Baker, 'Principles of Applied Bio-Medical Instrumentation', John Wiley and Sons, 1975.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Understand the physiology of biomedical system and related transducers	3
2	Analyze various electrical signals of biomedical instrumentation system.	4
3	Analyzevarious non-electrical parameters in biomedical fields.	4
4	Discuss and analyze physiological conditions using imaging techniques in medical diagnostics.	4
5	Apply clinical engineering techniques to create life assisting and therapeutic equipment.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3		3	3	2				3	2	
2	3	3	3	3		3	3	2				3	3	
3	3	3	3	3		3	3	2				3	2	
4	3	3	3	3		3	3	2				3	3	
5	3	3	3	3		3	3	2				3	3	

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22073	ETHICS IN ELECTRICAL ENGINEERING	LT P C
		3 0 0 3

COURSE OBJECTIVES

- To enable the students to create an awareness on Human Values
- To study Engineering Ethics and ethics applicable to Electrical engineering
- To instill Moral and Social Values and Loyalty and to appreciate the rights of others.
- To ensure safety in all engineering activities through realization of rights and responsibilities.
- To address global issues in the perspective of ethical knowledge

UNIT I	HUMAN VALUES	9

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self Confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II	ENGINEERING ETHICS	9

Engineering Ethics - definition. Senses of Engineering Ethics – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles – Electrical Engineering Ethics – Application of Ethical Theories.

UNIT III	ELECTRICAL ENGINEERING AS SOCIAL EXPERIMENTATION	9

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – Board of Electrical Engineering - IEEE code of Ethics- Problem Solving in Engineering Ethics

UNIT IV	SAFETY, RESPONSIBILITIES AND RIGHTS	9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – Electrical safety – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT V	GLOBAL ISSUES	9

Applications of Engineering Ethics - Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors –Corporate Social Responsibility.

TOTAL PERIODS:45

TEXT BOOKS

1.	Mike W. Martin and Roland Schinzinger, 'Ethics in Engineering', Tata McGraw Hill, New Delhi,2003.
2.	Govindarajan M, Natarajan S, Senthil Kumar V. S, 'Engineering Ethics', Prentice Hall of India, New Delhi, 2004.

REFERENCE BOOKS

1.	Laura P. Hartman and Joe Desjardins, 'Business Ethics: Decision Making for Personal Integrity and Social Responsibility' Mc Graw Hill education, India Pvt. Ltd., New Delhi, 2013.
2.	John R Boatright, 'Ethics and the Conduct of Business', Pearson Education, New Delhi, 2017.
3.	Charles B. Fleddermann, 'Engineering Ethics', Pearson Prentice Hall, New Jersey, 2004.

4.	Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, 'Engineering Ethics – Concepts and Cases', Cengage Learning, 2009.
5.	Edmund G Seebauer and Robert L Barry, 'Fundamentals of Ethics for Scientists and Engineers', Oxford University Press, Oxford, 2001.

COURSE OUTCOMES

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

CO's	STATEMENTS	RBT LEVEL
1	Summarize the importance of core values that shape the ethical behavior of a professional	2
2	Apply ethical theories in controversial issues while playing the role of electrical engineering Professionals.	3
3	Solve moral and ethical problems through exploration and assessment by established experiments and relate the code of ethics to social experimentation.	4
4	Enumerate the importance of electrical safety, responsibilities and rights of an engineer at work place	3
5	Analyze the ethical attributes of engineers in various roles and in different domains of engineering in the global context	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1								3	1			2		
2	1					2		3			1			
3	1	2		1	1			3						
4		2	2	1		2		3	1	1		1		
5						2	3	3	1	1	1	0		

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22074	IoT IN AUTOMATION AND CONTROL	LT P C
		3 0 0 3

COURSE OBJECTIVES

- To understand the fundamentals of Internet of Things
- To learn about how IoT can be utilized in manufacturing industry
- To apply IoT in control through cloud
- To apply IoT in control through PLC
- To apply the concept of IoT in the real-world scenario

UNIT I	INTRODUCTION AND ARCHITECTURE OF IoT	9

Introduction – Definition and characteristics of IoT – Physical and Logical Design of IoT - Communication models and APIs – Challenges in IoT - Evolution of IoT- Components of IoT - A Simplified IoT Architecture – Core IoT Functional Stack.

UNIT II	INDUSTRIAL IoT	9

IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture -IIoT-Business Models, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking

UNIT III	IIOT IN MANUFACTURING PROCESSES	9

Dimensions of IIoT: Production flow monitoring, Remote equipment management, Condition based maintenance alerts - Manufacturing operations- asset management - intelligent manufacturing - Automation through PLC - Pneumatic and Hydraulic control in Industries - PLC basics and Programming techniques - PLC control in Industrial applications through case studies

UNIT IV	DATA MANIPULATIONS AND ACQUISITION IN PLC	9

Analog sensors types and Interfacing with PLC - Receiving analog data from sensors to PLC for monitoring and Processing - Steps involved in designing SCADA application to monitor and control process through PLC - Data monitoring and acquisition from a process through SCADA and storage in Local PC / Server - Pneumatic application control and monitor using Arduino through Cloud

UNIT V	CASE STUDIES IN IIoT	9

Industrial IOT- Application Domains: Oil, chemical and pharmaceutical industry - Applications of UAVs in Industries -Real case studies: Milk Processing and Packaging Industries- Future of IIoT

TOTAL PERIODS:45

TEXT BOOKS

1.	Internet of Things (IoT) for Automated and Smart Applications, (IntechOpen) by Yasser Ismail, 2019
2.	Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress), 2017

REFERENCE BOOKS

1.	Industrial IoT - Challenges, Design Principles, Applications, and Security - Springer, Ismail Butun, 2020.
2.	Industrial Internet of Things: Cyber manufacturing Systems, by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer), 2017.
3.	Internet of Things (IoT) for Automated and Smart Applications, (IntechOpen) by Yasser Ismail, 2019.
4.	Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Antonio Capasso, Packt, 2018.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Summarize the basic concepts and architecture of the Internet of Things.	2
2	Comprehend the various layers of IIoT and their relative importance.	2
3	Analyze the several dimensions of IIoT and PLC involved in automation.	4
4	Examine the data acquired by the sensors to PLC and monitor and control processes through PLC	4
5	Apply the concepts of IIoT and formulate the future of IIoT in various domains.	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	1									2			1
2	3	1									2			1
3	3	3			2						2			2
4	3	3	2								2			2
5	3	1				3					2			3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

IT22201	COMPUTER ORGANIZATION AND ARCHITECTURE	L T P C
	(COMMON TO IT AND EE)	3 0 0 3

COURSE OBJECTIVES

- To make students understand the basic structure and operation of digital computer
- To understand the hardware-software interface
- To familiarize the student with arithmetic and logic unit and implementation of fixed point and floating-point arithmetic operations.
- To familiarize the students to the concept of pipelining along with hierarchical memory system including cache memory and virtual memory
- To expose the students with different ways of communicating with I/O devices and standard I/O interfaces.

UNIT I	BASIC COMPUTER ORGANIZATION AND DESIGN	9

Instruction codes, Computer registers, computer instructions, Timing and Control, Instructioncycle, Memory-Reference Instructions, Input-output and interrupt, Complete computerdescription, Design of Basic computer, design of Accumulator Unit.

UNIT II	ALU AND CU	9

ALU - Addition and subtraction – Multiplication – Division – Floating Point operations – Subwordparallelism. CPU- General Register Organization, Stack Organization, Instruction format,Addressing Modes, data transfer and manipulation, Program Control, Reduced Instruction SetComputer (RISC).

UNIT III	PIPELINING AND HAZARDS	9

Basic MIPS implementation – Building data path – Control Implementation scheme – Pipelining – Pipelined data path and control – Handling Data hazards & Control hazards – Exceptions, The ARMCortex-A8 and Intel Core i7 Pipelines.

UNIT IV	MEMORY AND I/O SYSTEMS	9

Memory hierarchy - Memory technologies – Cache basics – Measuring and improving cacheperformance -- Input/output system, programmed I/O, DMA and interrupts, I/O processors.

UNIT V	MULTICORES, MULTIPROCESSORS, AND CLUSTERS	9

Shared Memory Multiprocessors, Clusters and Other Message-Passing Multiprocessors HardwareMultithreading, SISD, MIMD, SIMD, SPMD, and Vector, Introduction to Graphics Processing Units,Clusters, Warehouse Scale Computers, and Other Message-Passing Multiprocessors.

TOTAL PERIODS: 45

TEXT BOOKS

1.	David A. Patterson and John L. Hennessey, 'Computer organization and design',Morgan kauffman / elsevier, 2014, 5th edition.

REFERENCE BOOKS

1.	V. Carl Hamacher, Zvonko G. Varanesic and Safat G. Zaky, 'Computer Organisation',McGraw-Hill Inc, 2012,6th edition.
2.	William Stallings 'Computer Organization and Architecture', PearsonEducation, 2006, 7th Edition.
3.	Vincent P. Heuring, Harry F. Jordan, 'Computer System Architecture', Pearson Education, 2005, 2nd edition.
4.	Govindarajalu, 'Computer Architecture and Organization, Design Principles andApplications',

	Tata McGraw Hill, New Delhi, 2005, 1st Edition.
5.	John P. Hayes, 'Computer Architecture and Organization', Tata McGraw Hill,1998, 3rd Edition.
6.	http://nptel.ac.in/.

COURSE OUTCOMES

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

CO's	STATEMENTS	RBT LEVEL
1	Build the basic structure of computer, operations and instructions.	3
2	Design arithmetic and logic unit.	3
3	Design and analyze pipelined control units.	3
4	Evaluate performance of memory and I/O systems.	5
5	Construct the parallel processing architectures.	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	1	3							3			2		
2	1	3							3			2		
3	1		3	2	1				3			2		
4	1		3	2	1				3			2		
5	1		3	2	1				3			2		

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22075	ARTIFICIAL AND COMPUTATIONAL INTELLIGENCE	LT P C
		3 0 0 3

COURSE OBJECTIVES

- To impart knowledge about the importance of Artificial Intelligence.
- To learn various problem-solving processes and procedures.
- To give understanding of the main abstractions behind development of intelligent systems.
- To enable the students to understand the basic principles of Artificial Intelligence in various applications.
- To enable the students to understand the basic principles of Computational Intelligence in various applications.

UNIT I	INTRODUCTION TO AI	9

Introduction to AI –Evolution of AI - AI Applications - Need and Importance of AI - Approaches of AI – Agents and Environments – concept of rationality – nature of environments – structure of agents - Problem solving agents – search algorithms – uninformed search strategies.

UNIT II	PROBLEM SOLVING TECHNIQUES	9

Heuristic search strategies – heuristic functions. Local search and optimization problems – local search in continuous space – search with non-deterministic actions – search in partially observable environments – online search agents and unknown environments

UNIT III	COMPUTER INTELLIGENCE (CI)	9

Machines and Cognition – Architectures of Cognition – Knowledge Based Systems – Logical Representation and Reasoning – Logical Decision Making –Learning – Language – Vision.

UNIT IV	NEURAL NETWORKS	9

Perceptron - Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error backpropagation, from shallow networks to deep networks –Unit saturation (aka the vanishing gradient problem) – ReLU, hyperparameter tuning, batch normalization, regularization, dropout.

UNIT V	ARTIFICIAL INTELLIGENCE OF THINGS (AIoT)	9

Concept and working of AIoT- Benefits of AIoT–IoT vs AIoT - Advanced Applications of IoT with AI - Autonomous vehicles - Future perspectives of AI-driven Internet of Things - Challenges in AIoT

TOTAL PERIODS:45

TEXT BOOKS

1.	Artificial Intelligence, ‘A Modern Approach,Stuart Russell and Peter Norvig’, Pearson Education, 2021, 4th Edition.
2.	Deepak Khemani ‘Artificial Intelligence’ Tata Mc Graw Hill Education 2013.

REFERENCE BOOKS

1.	Elaine Rich, Kevin Knight, Shivashankar B. Nair, ‘Artificial Intelligence’. Tata McGraw-Hill Education Pvt. Ltd., 2008, 3rd Edition.
2.	Toshinori Munakata, ‘Fundamentals of the New Artificial Intelligence’ Springer Science and Business Media, 2008.
3.	Handbook On Computational Intelligence (In 2 Volumes), World Scientific, 2016

4.	R.Eberhart, P.Simpson and R.Dobbins, AP, 'Computational Intelligence - PC Tools', Professional, Boston, 1996
5.	NPTEL-FundamentalsofArtificialIntelligencehttps://onlinecourses.nptel.ac.in/noc22_ge29/preview

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Summarize the importance of AI and understand its concept and various approaches	2
2	Apply methodologies to use appropriate search algorithms for problem solvingand development of Artificial Intelligent systems	3
3	Connect to the cognition elements computationally building the intelligent computing network	4
4	Set up sophisticated deep learning models that utilise neural networks.	3
5	Relate the concept of AI and IoT to numerous operations and demonstrate its applications and future perspectives	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	1	1			1						1	2		1
2	2	3	3	3	2						3	2		2
3	2	2	2		2						1	2		2
4	3	2	2		2						2	3		3
5	3	2	1		2	3	3				2	3		3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

ME22087	PRINCIPLES OF MANAGEMENT	LT P C
	(COMMON TO ME, AE, AM, EE, IT AND MN)	3 00 3

COURSE OBJECTIVES

- To enable the students to study the evolution of management
- To study the functions planning, organizing and the associated principles of management
- To study the function directing and the associated principles of management
- To study the functions controlling and the associated principles of management
- To learn the application of management principles in an organization.

UNIT I	INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS	9

Definition of Management — Science or Art — Manager Vs Entrepreneur — types of managers - managerial roles and skills — Evolution of Management — Scientific, human relations, system and contingency approaches — Types of Business organization — Sole proprietorship, partnership, company-public and private sector enterprises — Organization culture and Environment — Current trends and issues in Management.

UNIT II	PLANNING	9

Nature and purpose of planning — planning process — types of planning — objectives — setting objectives — policies — Planning premises — Strategic Management — Planning Tools and Techniques — Decision making steps and process.

UNIT III	ORGANISING	9

Nature and purpose — Formal and informal organization — organization chart — organization structure — types — Line and staff authority — departmentalization — delegation of authority — centralization and decentralization — Job Design — Human Resource Management — HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management

UNIT IV	DIRECTING	9

Foundations of individual and group behaviour — motivation — motivation theories — motivational techniques — job satisfaction — job enrichment — leadership — types and theories of leadership – communication — process of communication — barrier in communication — effective communication – communication and IT.

UNIT V	CONTROLLING	9

System and process of controlling — budgetary and non-budgetary control techniques — use of computers and IT in Management control — Productivity problems and management — control and performance — direct and preventive control — reporting.

TOTAL PERIODS:45

TEXT BOOKS

1.	John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, 4 th edition New York, 2009.
2.	Arumugam M, "Biomedical Instrumentation", Anuradha Agencies Publishers, Chennai, 2010.

REFERENCE BOOKS

1.	Stephen P. Robbins, Mary Coulter and Agna Fernandez, "Management", Prentice Hall (India) Pvt. Ltd., 2019, 14th Edition.

2.	Harold Koontz & Heinz Weihrich "Essentials of management" 10th edition, Tata Mc Graw Hill, 2015.
3.	JAF Stoner, Freeman R.E and Daniel R Gilbert "Management", Pearson Education, 2004, 6th Editon.
4.	Heinz Weihrich, Mark V Cannice, and Harold Koontz, 'Management: A Global, Innovative and Entrepreneurial Perspective',McGrawHill, 2019, 15thEditon.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Apply managerial approaches and practice managerial roles as demanded by the current environment of the organization.	3
2	Develop planning process and apply strategies, planning tools and techniques to attain organizational objectives.	4
3	Effectively organize activities in the organization and execute human resource management tasks	4
4	Execute the appropriate motivational and leadership techniques and effectively utilize communication methods in the organization	4
5	Apply control techniques to monitor the progress of activities and to take corrective measures accordingly	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1						1				1	1	1		
2		2	2		1	1				1	1	1		
3			2	1	1			1		1	1	1		
4	1		1	1	1	2	1	1	1	2	2	1		
5	1		1	1	1	2	1	1	1	2	2	1		

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EC22066	ROBOTICS AND AUTOMATION	L T P C
	(COMMON TO EC AND EE)	3 0 0 3

COURSE OBJECTIVES

- To acquire basic knowledge on robotics and associated automation principles along with the existing industrial applications.
- To explore on various types of sensors, robot actuators, end effectors concerned with manipulators.
- To study about robot motion analysis and control.
- To acquire knowledge on vision system for robotic applications.
- To explore on robotics automation and applications in industry.

UNIT I	FUNDAMENTALS OF ROBOTICS AND AUTOMATION	9

Robotics: Definition, Origin, Different types, Various generations –Degrees of freedom; Anatomy of a robot – Classification of robots – Cartesian, Cylindrical, Spherical, Articulated, SCARA; Precision of robot movements – Accuracy, Resolution, Repeatability– specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load.

Automation: Basic elements of an automated system – Level of automation; Computer process control – Control requirements, Forms of computer process control. Material handling applications through industrial robotics (Brief overview at introduction level): Material transfers – Machine loading and unloading.

UNIT II	SENSORS AND ACTUATORS	9

Sensors: Sensor characteristics, Types of sensors – Tactile sensors, Touch sensors; Position sensors – Potentiometer, Encoder, LVDT, Resolvers; Proximity sensors – Magnetic, Optical, Ultrasonic, Inductive, Capacitive, Eddy current; Speed sensors – Velocity/motion sensors; Force/Pressure and torque sensors.

Actuators: Mechanical Actuation System – Cams, Gear trains, Ratchet and Pawl, Belt and chain drives, Bearings; Electrical Actuation System– Electrical systems, Solid State Switches, Solenoids, Stepper motors; Introduction to Hydraulic and Pneumatic Systems, Directional Control valves, Flow control valves, End Effectors.

UNIT III	ROBOT MOTION ANALYSIS AND CONTROL	9

Overview on controller and its types – PI, PD, PID; Manipulator kinematics – Position representation and orientation – Forward, Reverse and Homogeneous transformation – Kinematic equations – Solving Inverse kinematic equations; Overview on Manipulator path control – Slew, Joint interpolated and Straightline motion; Differential motions – Jacobian; Robot dynamics – Static analysis – Robot arm dynamics – Newton-Euler method – Euler-Lagrangian formulation; Force control – Tasks, Strategies.

UNIT IV	ROBOTIC VISION AND INDUSTRIAL AUTOMATION	9

Architecture and components of robotic vision systems – Image acquisition and representation, Stereo vision – Image histograms – Spatial operations – Smoothing – Segmentation – Object descriptors – Object Recognition.

Analysis of Automated Flow Lines: General Terminology and Analysis, Analysis of Transfer Lines without Storage, Partial Automation, Automated Flow Lines with Storage Buffers.

UNIT V	AUTOMATION IN INDUSTRIAL APPLICATIONS	9

Flexible Manufacturing Systems – Components, Planning and implementation issues, Benefits and applications; Automated Storage Retrieval Systems (ASRS) – types, components and operating features; Automated processing/machining – Transfer lines; Automatic assembly – System configuration, parts delivery, applications; Automatic inspection – types, procedure, accuracy; Material Handling-palletizing and depalletizing.
TOTAL: 45 PERIODS

TEXT BOOKS	
1.	Mikell P. Groover, Mitchell Weiss, Roger N. Nagel and Nicholas G. Odrey, 'Industrial Robotics', Tata Mc Graw Hill, 2010.
2.	Peter Corke, 'Robotics, Vision and control-Fundamental algorithms in MATLAB', Springer International publishing AG, 2017.
3.	Mittal R K, Nagrath I J, 'Robotics and control', Tata McGraw Hill, 2010.
REFERENCE BOOKS	
1.	Ganesh.S.Hedge,'A textbook of Industrial Robotics', Lakshmi Publications, 2006.
2.	Fu. K. S., Gonzalez. R. C. & Lee C.S.G., 'Robotics control, sensing, vision and intelligence', McGraw Hill Book co, 1987.
3.	Saeed B. Niku, 'An Introduction to Robotics: Analysis, systems and applications', Pearson Education, 2009.
4.	Richard D Klafter, and Michael Negin, 'Robotics Engineering', Prentice Hall, 2009.
5.	John.J. Craig, 'Introduction to Robotics: Mechanics and control', Pearson Education, 2009.

COURSE OUTCOMES

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

COs	**STATEMENTS**	**RBT LEVEL**
1	Categorize robots and automation based on various aspects	2
2	Identify appropriate sensors, robot actuators, end effectors for certain applications	3
3	Solve the basic manipulator kinematics, robot dynamics and sketch the manipulator path control	3
4	Design appropriate vision system for certain robotic applications	3
5	Acquire knowledge on robotics for certain automation in industry	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3									2	3	3
2	3	3	3	2		2	2					2	3	3
3	3	3	3			2	2					2	3	3
4	3	3	3	2		2	2					2	3	3
5	3	3	3			2	2					2	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22070	DESIGN THINKING LABORATORY	LT P C
		0 0 4 2

COURSE OBJECTIVES

- Instill the foundational principles of design thinking.
- Cultivate students into adept designers, fostering creativity and honing their problem-solving skills.
- Conceive, conceptualize, and demonstrate innovative ideas through the development and presentation of prototypes.

The course will use a combination of lectures and hands-on project work. The project will give an opportunity to come up with an innovative engineering solution to problems or challenges particular to our society.

LIST OF EXPERIMENTS

1	Introduction to Design Thinking, Significance of Design Thinking, Key Tenets of Design Thinking Design Thinking Process- 4 Critical Questions and human centered design thinking.
2	Identifying societal problems using indirect and qualitative research.
3	Forming teams and assignments of major societal problems and arriving at sound concept hypotheses, and solution using brainstorming sessions. Societal problems such as water management, energy sources, basic amenities (health, education, food, clean water, sanitation, connectivity etc), organic farming, livelihood etc. will be assigned as projects.
4	Developing a prototype that allows for meaningful feedback in a real-world environment.
5	Concept of Prototyping, Scenario prototype, Low fidelity and high fidelity
6	Introduction to Test, 5 Guidelines for Conducting a Test, The End Goal: Desirable, Feasible and Viable Solutions, Role of Evaluative Research in Test Phase Usability Test Heuristic Evaluation Test your Prototype
7	Presenting the developed prototype in front of a technically qualified audience. Evaluation will be done as per following details.

TOTAL PERIODS:60

TEXT BOOKS

1.	Pavan Soni (2020), Design Your Thinking: The Mindsets, Toolsets, and Skill Sets for Creative Problem-solving, Penguin Random House India Private Limited
2.	Gavin Ambrose, Paul Harris, “Basics Design - 8: Design Thinking”, illustrated, reprint, AVA Publishing, 2010

REFERENCE BOOKS

1.	Christian Müller-Roterberg, “Handbook of Design Thinking”, Kindle Direct Publishing ISBN: 978-1790435371, November 2018
2.	Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Collins Publishers Ltd.
3.	IdrisMootee, Design Thinking for Strategic Innovation,2013, John Wiley & Sons Inc
4.	Roger Martin (2009), The Design of Business, Harvard Business Review Press
5.	Devyani Lal Design Thinking- Beyond the sticky Notes, Sage.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Demonstrate the critical theories of design, systems thinking, and design methodologies	4
2	Create effective solutions for given problems	6
3	Make prototypes of a model / concept technically.	4
4	Work as a team member or lead interdisciplinary engineering teams.	4
5	Demonstrate the product prototype to technically qualified audience.	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
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

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

VALUE ADDED COURSES

VD22601	INDUSTRIAL APPLICATIONS OF MICROCONTROLLERS	L T P C
		1 0 2 2

COURSE OBJECTIVES

- To gain knowledge on automation in industries using microcontrollers.
- To impart the microcontroller configuration and development.
- To introduce sensor interfacing and data acquisition.
- To impart actuator control and system integration.
- To provide knowledge on communication and networking in industrial applications.

UNIT I	INTRODUCTION TO INDUSTRIAL AUTOMATION AND MICROCONTROLLERS	9

Definition and scope of industrial automation – Importance of automation in modern industries – Introduction to microcontrollers and their features – advantages of using microcontrollers in industrial automation – comparison with other control systems (PLCs, PCs) – Common industrial communication protocols (Modbus, Profibus, Ethernet/IP) – Criteria for selecting microcontrollers based on application requirements – considerations for performance, power consumption, cost and scalability – Microcontroller families suitable for industrial automation (ARM Cortex-M, PIC, AVR)

UNIT II	MICROCONTROLLER CONFIGUTARION AND DEVELOPMENT	9

Integrated Development Environments (IDE) for microcontroller programming – Installation and configuration of compiler toolchains, debuggers, and programmer tools – selection of development boards and hardware platforms for microcontroller projects - Interfacing microcontroller with industrial communication networks – Testing and debugging communication interfaces for reliability and compatibility – Introduction to Real Time Operating Systems (RTOS) and their characteristics – Using RTOS in microcontroller based industrial automation – Implementation of task scheduling, priority management and synchronization in RTOS – based applications.

UNIT III	SENSOR INTERFACING AND DATA ACQUISITION	9

Sensor in industrial applications (temperature, pressure, level, flow, etc.) – Analog and digital sensor interfacing techniques – signal conditioning and filtering for accurate sensor readings – ADC techniques – configuration of ADC modules in microcontrollers - calibration and linearization techniques for ADC measurements – Calibration in sensor measurements – techniques for sensor calibration and compensation – signal conditioning methods for improving signal quality and accuracy.

UNIT IV	ACTUATOR CONTROL AND SYSTEM INTEGRATION	9

Actuators used in industrial automation (motors, values, relays etc.) – pulse width modulation (PWM) techniques for actuator control – Implementation of motor control algorithms for speed and position control – Interfacing actuators with microcontrollers for seamless integration into control systems – Design considerations for reliability, safety and efficiency – Testing and validation of actuator control systems in industrial environments.

UNIT V	COMMUNICATION AND NETWORKING IN INDUSTRIAL APPLICATIONS	9

Serial communication protocols used in industrial applications (RS-232, RS-485) – Configuration and implementation of serial communication interfaces in microcontrollers – error detection and correction

techniques for reliable data transmission – Introduction to Ethernet communication in industrial environments – Configuration of Ethernet interfaces in microcontrollers – Implementation of TCP/IP networking for data exchange and remote monitoring/control – wireless communication technologies used in industrial automation (Wi-Fi, Bluetooth, Zigbee) Integration of wireless modules into microcontroller based systems – security, reliability and range in wireless communication.
TOTAL PERIODS: 45

TEXT BOOKS	
1.	Jonathan W. Valvano, 'Embedded Systems: Real-Time Interfacing to ARM Cortex-M Microcontrollers', 2013, 5th Edition.
2.	Brain Amos, Jim Yuill, Penn Linder, 'Hands-On RTOS with Microcontrollers: Create high-performance, real-time embedded systems using Free RTOS, STM32 MCUs and SEGGER debug tools', 2024, Packt Publishing, 2nd Edition.
REFERENCE BOOKS	
1.	Brain Amos, Hands-On RTOS with Microcontrollers: Building real-time embedded systems using FreeRTOS, STM32 MCUs, and SEGGER debug tools, 2020, Packt Publishing.
2.	Arun Kumar, 'Medicine Manufacturing Industry Automation Using Microcontroller', 2013 Lambert Publications.
3.	Olushola AkandeOlushola Akande, 'Industrial Automation from Scratch: A hands-on guide to using sensors, actuators, PLCs, HMIs, and SCADA to automate industrial processes', 2023 Packt Publishing.

COURSE OUTCOMES

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

COs	**STATEMENTS**	**RBT LEVEL**
1	Analyze the concept of automation in industries using microcontrollers.	4
2	Analyze the microcontroller configuration and developments.	4
3	Analyze the sensor interfacing and data acquisitions.	4
4	Examine the actuator control and system integration in industrial automation.	4
5	Investigate the concept of communication and networking in industrial applications.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	3	3	2	2				1		2		3	2	3
2	3	3	2	3				1		2		3	2	3
3	3	3	2	3				1		2		3	2	3
4	3	3	2	3				1		2		3	2	3
5	3	3	2	3				1		2		3	2	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

VD22602	NANO-DEVICE MANUFACTURING	L T P C
		1 0 2 2

COURSE OBJECTIVES

Train the students on semiconductor process technology and microfabrication
Demonstrate various synthesis methods of nanostructures
Characterize the nanostructures
Hands-on training on nanostructure synthesis
Hands-on training on characterization of nanostructures

UNIT I	SEMICONDUCTOR PROCESSING AND MICROFABRICATION	9

Introduction to semiconductor processing – Necessity for a clean room– different types of clean rooms– Structure and requirements of a clean room– Safety issues, flammable and toxic hazards, biohazards – Microfabrication process flow diagram.

Experiment: RCA cleaning, coating of photoresists, patterning, etching, inspection – Process integration – Etching techniques– Wet and Dry Etching– Reactive Ion etching.

UNIT II	GENERAL METHODS OF PREPARATION	9

Preparation of nanoscale materials: Spray Pyrolysis, Co–Precipitation, Sol–gel, Mechanical Milling, Preparation of thin films: Electroplating, MOCVD, Plasma CVD, Molecular Beam Epitaxy, Atomic Layer Epitaxy and Pulsed layer deposition.

Experiment: Sputtering, Evaporation.

UNIT III	CHARACTERIZATION TECHNIQUES	9

Nano-processing systems – Nano measuring systems – characterization – analytical imaging techniques, X–ray diffraction technique, Scanning Electron Microscopy, confocal LASER scanning microscopy, transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, Raman spectroscopy, 3D surface analysis – Mechanical, Magnetic and thermal properties – Nano positioning systems.

Experiment: DLS, Electrical probe station.

UNIT IV	VACCUM TECHNOLOGY	9

Vacuum technology, Hands-on training and Demonstration on DC and RF Sputtering, Thermal Evaporation.

Experiment: Fabrication of two terminal solar devices.

UNIT V	DEVICE FABRICATION	9

Hands-on training and Demonstration on Photolithography, Spin coating, Atomic layer deposition, UV-visible spectroscopy, and Device structure case study.

Experiment: Three terminal solar devices, TFD Fabrication, Photo detector.

TOTAL PERIODS: 45

TEXT BOOKS

1.	T. Pradeep, Nano: The Essentials understanding Nanoscience and Nanotechnology, Tata McGraw Hill Education, 2007.
2.	Madou Marc J, 'Fundamentals of Microfabrication', CRC Press, New York, 1997.

REFERENCE BOOKS

1.	A S Edelstein and R C Cammarata, Nanomaterials Synthesis, Properties and Applications,

	IOP Publishing Ltd 1996.
2.	Frank J. Owens and Charles P.Poole, The Physics and Chemistry of Nano Solids, WileyInterscience, 2008
3.	Guozhong Cao, Nanostructures and Nanomaterials: Synthesis, Properties and applications, 2011.
4.	Charles P Poole, Frank J Owens, Introduction to Nano technology, John Wiley and Sons, 2003
5.	Mark Madou, Fundamentals of Microfabrication, CRC Press, New York, 1997.

COURSE OUTCOMES

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

CO	STATEMENTS	RBT LEVEL
1	Understand various semiconductor process technology and microfabrication methods	4
2	Synthesis nanostructures using variety of semiconductor technology for a given application	5
3	Characterize any specific nanostructure structurally, electrically and by imaging	4
4	Technically trained in the cleanroom protocol, vacuum technology, and physical deposition	4
5	Microfabricate any nano device and electrically characterize	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

CO	PO												PSO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	3	3	1	3	1	1	3	2	3	3	3	3
2	3	2	3	3	2	3	1	1	3	2	3	3	3	3
3	3	2	3	3	2	3	1	1	3	2	3	3	3	3
4	3	2	3	3	2	3	1	1	3	2	3	3	3	3
5	3	1	3	2	1	3	1	1	3	2	3	3	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

VD22603	MODELING AND SIMULATION OF ELECTRICAL SYSTEMS	L T P C
		1 0 2 2

COURSE OBJECTIVES

- Develop mathematical models for electrical and electronics components and simulate for performance evaluation.
- Analyze the simulation results of developed electrical circuits and systems

UNIT I	SIMULATION OF SEMICONDUCTOR DEVICES	9

Fundamentals of MATLAB coding for Electrical Stream - Fundamentals of SIMULINK for Electrical Stream -Simulation of Diode, Zener diode, BJT, FET/MOSFET - Simulation of Single phase half-wave and full-wave rectifiers.

UNIT II	ANALOG CIRCUITS AND DIGITAL CIRCUITS	9

Applications of Operational Amplifier - inverting & non-inverting amplifier and Adder - Comparator, Integrator and Differentiator - Simulation of Applications of Operational Amplifier - Steady State and Transient Analysis of DC and AC Circuits.

UNIT III	SENSORS, INSTRUMENTATION AND CONTROL SYSTEMS	9

Simulation of Transducers and its Applications - Simulation of ADC/DAC - Hands-on in instrumentation and its applications - Time Domain Analysis of First Order and Second Order Systems - Frequency Domain Analysis using Root Locus, Bode Plot, Polar Plot and Nyquist Plot - Hand-on in simulation of basic control systems.

UNIT IV	ELECTRICAL MACHINES	9

Performance Evaluation and Simulation of DC Generators and DC Motors - Simulation of performance of DC machines - Performance Evaluation and Simulation of AC motors, alternators and transformers - Simulation of performance of AC machines.

UNIT V	POWER SYSTEMS	9

Transmission Line Parameters Evaluation - Modeling and performance analysis of transmission lines - Hands-on in performance evaluation of transmission lines – Power flow analysis using Gauss-Seidal method – Fault analysis using Thevenin's method – Simulation of power flow and fault analysis.

TOTAL HOURS: 45

TEXT BOOKS

1	Millman J, Christos C Halkias, SatyabatraJit, 'Electronic devices and circuits', Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2008
2	M. Gopal, 'Modern control system Theory', New Age International, 2005

REFERENCE BOOKS

1	RamakantA.Gayakward, 'Op-amps and Linear Integrated Circuits', Pearson Education, 2003 / PHI. 2000, 4th Edition.
2	S. Mukhopadhyay, S. Sen and A. K. Deb, 'Industrial Instrumentation, Control and Automation', Jaico Publishing House, 2013
3	Hadi Saadat, 'Power System Analysis', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.
4	Donald A Neamen, 'Electronic Circuit Analysis and Design' Tata McGraw Hill, 2003, 3rd Edition.
5	A.E.Fitzgerald, Charles Kingsley, Stephen. D.Umans, 'Electric Machinery', Tata McGraw Hill publishing Company Ltd, 2003

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Expertise in the available simulation software packages	3
2	Develop models for electrical and electronics components	4
3	Develop models for electrical circuits and systems	4
4	Simulate for performance evaluation of modeled components	4
5	Analyze the simulation results of implemented circuits and systems	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	2	2			2	2	2			3	3
2	3	3	3	2	2			2	2	2			3	3
3	3	3	3	3	2			2	2	2			3	3
4	3	3	3	3	2			2	2	2			3	3
5	3	3	3	3	2			2	2	2			3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

VD22604	ELECTRIC VEHICLE DESIGN	L T P C
		1 0 2 2

COURSE OBJECTIVES

- To introduce the architecture and design of electric vehicle components.
- To model and simulate continuous and discrete systems.
- To impart the knowledge on the design of drive train, motors, controllers, battery.
- Learn to model and analyze direct current (dc) power electronic systems.

UNIT I	ARCHITECTURE DESIGN AND VEHICLE DYNAMICS	9

Types of Electric Vehicle and components - Battery Electric vehicle (BEV) - Hybrid electric vehicle (HEV) - Plug-in hybrid vehicle (PHEV) -Fuel cell electric vehicle (FCEV)

Vehicle body modeling: Friction, wind, and terrain effects - Sensing physical quantities

UNIT II	PHYSICAL MODELING OF CONTINUOUS AND DISCRETE SYSTEMS	9

Modeling Continuous Systems: Model and simulate continuous systems in Simulink Continuous states - DC motor system - Continuous transfer functions and state-space systems

Modeling Discrete Systems Model: Discrete signals and states - PI controller system - Discrete transfer functions and state-space systems

UNIT III	MODELING AND CONTROL OF DC MOTOR	9

Selection and sizing of motor for EV– Speed and Torque calculation of motor - Motor Controllers - Component sizing – Function of control unit - Current control in DC motors • Speed Control in DC motors

UNIT IV	MODELING OF POWER ELECTRONIC SYSTEMS	9

Modeling a boost converter for EV - Measuring physical quantities - Implementing closed-loop voltage control - Linearizing power electronic converters - Tuning the controller -Modeling a three-phase inverter - Measuring three-phase physical quantities

UNIT V	CASE STUDY	9

Design case study on 2wheeler, 3wheeler and 4wheeler EV system.

TOTAL PERIODS: 45

REFERENCE BOOKS

1.	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2018, 3rd Edition.
2.	Iqbal Hussein, 'Electric and Hybrid Vehicles: Design Fundamentals', CRC Press, 2021, 3rd Edition.
3.	James Larminie, John Lowry, 'Electric Vehicle Technology Explained', Wiley, 2012, 2nd Edition.

COURSE OUTCOMES		
Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Select and design the architecture of Electric Vehicle considering vehicle dynamics.	4
2	Model and simulate continuous and discrete physical systems.	4
3	Model the motors for electric vehicles and implement the speed control techniques.	4
4	Design controller for power electronic converters in EV.	5
5	Determine the Electric Vehicles sizing and requirements.	3
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	3	3	3	2	3	2	2		2	2		3	3	
2	3	3	3	2	3	2	2		2	2		3	3	
3	3	3	3	2	3	2	2		2	2		3	3	
4	3	3	3	2	3	2	2		2	2		3	3	
5	3	3	3	2	3	2	2		2	2		3	3	

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

VD22605	ELECTRONIC CIRCUITS DESIGN AND PCB FABRICATION	LTP C
		10 2 2

COURSE OBJECTIVES

- To understand the concept of multistage amplifier and feedback amplifiers.
- To design and analyze of power amplifiers.
- To design and analysis of LC and RC oscillators, multivibrators.
- To design a schematic of electronic circuit and to design PCB layout.

UNIT I	MULTISTAGE AND FEEDBACK AMPLIFIERS	9

Need of Cascading, evaluation of Ri, Ro, Ai, Av, Types of coupling, RC coupled, Transformer coupled, Direct coupled amplifier. Design of two-stage RC coupled amplifier with and without feedback and Direct coupled amplifier. Need and advantages of negative feedback amplifier, types of negative feedback amplifiers, study of Emitter follower and Darlington amplifier with bootstrapping principle.

UNIT II	POWER AMPLIFIERS	9

Need of Power amplifier, Classification of power amplifier, Power considerations, Calculation of 2nd order Harmonic using Three-point method, Analysis & Design of Class A single-ended transformer-coupled amplifier, Class B amplifier & class B push-pull amplifier, Cross over distortion, and methods to eliminate cross over distortion, complimentary symmetry amplifier.

UNIT III	OSCILLATORS AND MULTIVIBRATORS	9

Barkhausen's criteria, Frequency and amplitude stability, classification of the oscillator, RC Oscillators: analysis and design of RC phase shift, Wein bridge using BJT, Colpitts and Hartley oscillator using BJT, Crystal oscillator. Classification of Multivibrator, analysis, and design of bistable, monostable & astable multivibrator.

UNIT IV	INTRODUCTION TO PCB DESIGNING	9

History of Printed Circuit Boards. Various types of Printed Circuit Boards-Single Sided Boards, Double Sided Plated through Hole Boards, multilayer Boards. Study of Packages of Electronic Components. Study of SMD Components. Process of PCB design and product development flow.

UNIT V	PRINTED CIRCUIT BOARD DESIGN	9

Rules for singleand DoubleSided Board. Schematic diagram Entry in PCB Design tool/S/W. Layout Design, Routing methods. Guideline for Artwork Generation. Generation of various Manufacturing Documents/ Output file generation. Component Library management in PCB Design tool.

TOTALPERIODS:45

TEXT BOOKS	
1.	Sedra and Smith, 'Micro Electronic Circuits'; Oxford University Press, 2011, 6th Edition.
2.	Muhammad H. Rashid, "Power Electronics: Circuits, Devices & Applications", Pearson Education / PHI, 2014, 4th Edition.
REFERENCE BOOKS	
1.	T.H.O'Dell, Electronic Cicuit Design, Art and Practice, Cambridge university press,1992, 1st Edition.
2.	Paul Horowitz, Winfield Hill, "The Art of Electronics" Cambridge university press, 2015, 3rdEdition.
3.	Robert L. Boylestad and Louis Nasheresky, "Electronic Devices and Circuit Theory", Pearson Education / PHI, 2008, 10th Edition.
4.	David A. Bell, "Electronic Devices and Circuits", Oxford University Press, 2008, 5th Edition.

COURSEOUTCOMES Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Analyze the concepts of multistage and feedback amplifiers.	3
2	Analyze and design various Power amplifier circuits.	6
3	Investigate and design Oscillators and Multivibrator circuits	6
4	Acquire the basic level knowledge and will understand the packages ofElectronic components, types of PCBs and history of PCBs.	2
5	Understand the rules before PCB Designing, the flow of computer aided design packages and will Acquire the importance of manufacturing documents.	6
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3	2	2	1	1	1		3	3	3	
2	3	3	3	3	2	2	1	1	1		3	3	3	
3	3	3	3	3	2	2	1	1	1		3	3	3	
4	3	3	3	3	3	2	1	1	1		3	3	3	
5	3	3	3	3	3	2	1	1	1		3	3	3	
3- High Mapping; 2-Moderate Mapping; 1-Low Mapping														

VD22606	DESIGN AND FABRICATION OF PHOTOVOLTAIC SYSTEM	L T P C
		1 0 2 2

COURSE OBJECTIVES

- Insights into the structure, materials and operation of solar cells, PV modules, and arrays.
- Fabricate thin film solar cell and characterize electrically.
- Simulate and model emerging PV technologies for various applications
- Design a standalone and grid-connected PV systems
- Design a PV system for a particular commercial application.

UNIT I	INTRODUCTION TO SOLAR CELL	9

Overview of Global Scenario in Renewable Energy, semiconductors and P-N junctions - behavior of solar cells – Properties – PV cell interconnection.

UNIT II	PV CELL FABRICATION AND CHARACTERIZATION	9

Simulation: Software tools for solar cell design – designing of single junction and multijunction solar cell-efficiency calculation.

Device fabrication: Substrate and material selection, Deposition Methods, Metal Patterning and Characterization of solar cell.

Experiments:

1. Simulation of single and multi-junction solar cell
2. I-V characteristics of Solar cell

UNIT III	PV COMMERCIAL AND EMERGING TECHNOLOGY	9

Overview of commercial technologies - Crystalline Si (c-Si), Thin film PV, CdTe and CIGS- Emerging Technologies: Organic PV (OPV), Perovskites, CZTS

Experiment:

1. Simulation and modeling of CdTe based thin film solar cell and Seminar presentation

UNIT IV	PV SYSTEM DESIGN	9

Designing of standalone PV system- Block diagram of PV system- Buck boost converter- Inverter selection - Battery sizing - Array sizing - Grid connected PV systems and issues

Experiment:

1. Design a PV system for residential load.

UNIT V	PV APPLICATIONS	9

Water pumping – battery chargers – Electric Vehicle – Space applications – Solar farm.

Experiment:

1. Design a PV system for commercial applications.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Chetan Singh Solanki., Solar Photovoltaic: 'Fundamentals, Technologies andApplication', PHI Learning Pvt., Ltd., 2009.
2.	A.K.Mukerjee and Nivedita Thakur, 'Photovoltaic Systems: Analysis and Design', PHI Learning Private Limited, New Delhi, 2011.

REFERENCES

1.	Photovoltaics: Fundamentals, Technology and Practice. Konrad Mertens,Wiley, 2019, 2nd Edition.
2.	Roger A Messenger and Jerry Ventre, "Photovoltaic Systems Engineering", CRCPress,

	Taylor & Francis Group, 2004, 2nd Edition.
3.	Eduardo Lorenzo G. Araujo, Solar electricity engineering of photovoltaic systems, Progensa, 1994.
4.	Stuart R.Wenham, Martin A.Green, Muriel E. Watt and Richard Corkish, Applied Photovoltaics, 2007, Earthscan, UK.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Analyze PV devices and systems based on semiconductor physics	4
2	Experimentally design and fabricate a thin film solar cell and measure the electrical parameters.	4
3	Mathematically model a thin film solar cell and simulate its electrical parameters.	4
4	Design of solar PV system based on a given load.	4
5	Mathematically model and analyze a PV system for commercial load	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	2		2	3	2						3
2	3	3	3	3	3		3	3	3	3				3
3	3	3	3	3	3		3	3	3	3		3		3
4	3	3	3	3	3	3	3	3	3	3				3
5	3	3	3	3	3	3	3	3	3	3				3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

VD22607	SMART GRID CYBERSECURITY	L T P C
		1 0 2 2

COURSE OBJECTIVES

- Learn the smart grid communications and power system contingency.
- Understand about Power System Resilience metrics, event modelling for analysis and system recovery.
- To impart a knowledge on smart grid security challenges and data protection.
- To get familiarized with Smart grid threats, Risk Assessment and emerging solution techniques.
- Introduce solution for physical attack and solution for secure communication.

UNIT I	BASIC CONCEPTS	9

Smart Grid communication, physical and network, introduction to SCADA, MTU, HMI, PLCs, RTU, Physical communications and protocols, Power system observability, bad data detection and identification, Introduction to power system contingency.

Experiment:

Programming on Bad data detection and identification in power system state estimation with network parameters uncertainty on simple power network.

UNIT II	POWER SYSTEM RESILIENCE METRICS	9

Contingency Vs resiliency analysis: need of resiliency, Elements of Power System Resilience, metrics for system resiliency, Extreme events modelling, Weather-related events, enhancing power system resiliency.

Experiment:

Mathematical Modelling of power system resilience metrics for smart grid operational and infrastructure

UNIT III	SMART GRID SECURITY CHALLENGES	9

Security Goals and Challenges in Smart Grid Implementation, Importance of security, Classification of the threats, Security Analytics for AMI, SCADA and EMS Modules, Smart Grid Security and Privacy of Customer-Side Networks, Protection against False Data Injection (FDI) Attacks, SecureCommunications in Smart Grid.

Experiment:

Modelling and Simulations of detected FDI attacks in the control room to secure power system using simple power network.

UNIT IV	SMART GRID THREAT AND CROSS-DOMAIN RISK	9

Smart Grid threat Landscape, Smart Grid Risk Assessment, Challenges and solutions, Emerging methods and techniques for the smart grid security

Experiment:

Analysis, modelling, Risk and Impact Assessments for IoT Threats to the Smart Grid

UNIT V	SMART GRID RESILIENCY AND CYBER ATTACK	9

Types of physical attack on smart grid devices, Hardware security modules, Analytics for Smart Grid Security and Resiliency, Cyber security solutions for control and monitoring system, Control centric security tools.

Experiment:

Resilience enhancements using tie-lines and DGs to help to recovery test system after the system was struck and damaged by any natural calamities or cyber-attacks.

TOTAL HOURS: 45

TEXT BOOKS

1.	Security and Resiliency Analytics for Smart Grids, Al-Shaer, Ehab, Rahman and Mohammad Ashiqur, Springer Intr, 2016, 1st Edition.
2.	Smart Grid Security, S. Goel, Y. Hong, V. Papakonstantinou, D. Kloza, Springer-Verlag,

	2015, 1st Edition
REFERENCE BOOKS	
1.	Security and Privacy in Smart Grid, A. Abdallah and X. Shen, Springer Intr., 2018, 1stEdition.
2.	Smart grids security challenges: Classification by sources of threat, Abdul Rahaman, Journal of Electrical Systems and Information Technology, 2018.
3.	Power System State Estimation: Theory and Implementation, A. Abur and A. G. Exposito, CRC Press, 2004, 1st Edition.
4.	Probability and Stochastic Processes: A Friendly Introduction for Electrical and Computer Engineers, Roy D. Yates, David J. Goodman, Wiley, 2014, 3rdEdition.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Understand the smart grid communication protocols and power system contingency	3
2	Acquire knowledge about important technical threat categories, communication protocols, and resilient smart grid systems.	3
3	Implement risk management, operational security, and a secure Smart Grid development process.	4
4	Assess static and dynamic security analysis techniques to validate	5
5	Validate smart grid security and resiliency	5

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3		2		1		2	1				3
2	3	3	3	2	2		2	2	2	1				3
3	3	3	3	3	2		2	2	2	1				3
4	3	3	3	3	2		2	2	2	1				3
5	3	3	3	3	2		2	2	2	1				3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

VD22608	APPLIED INDUSTRIAL IOT	L T P C
		1 0 2 2

COURSE OBJECTIVES

- To introduce the architecture and components used in IIOT.
- To impart the communication topologies of IIOT.
- To investigate data types of IIOT.
- To develop the concept of retrieving data from Web.
- To investigate the control concepts and supervisory level of automation.

UNIT I	INTRODUCTION OF IIOT ARCHITECTURE AND COMPONENTS	9

Theory

IoT and the connected world - difference between IoT and IIoT- Architecture of IIoT - IoT node - Challenges of IIoT - Introduction to Sensors (Description and Working principle): Types of sensors: Ultrasonic Sensor - IR sensor - MQ2 - Temperature and Humidity Sensors (DHT-11) - Digital switch - Electro-Mechanical switches.

UNIT II	COMMUNICATION TECHNOLOGIES OF IIOT	9

Theory

Communication Protocols: IEEE 802.15.4 - ZigBee - Z Wave – Bluetooth – BLE – NFC - RFID

Industry standards communication technology (LoRAWAN, OPC UA, MQTT) - connecting into existing Modbus and Profibus technology - wireless network communication.

UNIT III	VISUALIZATION AND DATA TYPES OF IIOT	9

Theory

Front-end EDGE devices - Enterprise data for IIoT - Emerging descriptive data standards for IIoT - Cloud data base - Could computing - Fog or Edge computing - Connecting an Arduino/Raspberry pi to the Web: Introduction - setting up the Arduino/Raspberry pi development environment - Options for Internet connectivity with Arduino - Configuring your Arduino/Raspberry pi board for the IoT.

UNIT IV	RETRIEVING DATA FROM WEB	9

Theory

Extraction from Web: Grabbing the content from a web page - Sending data on the web, Troubleshooting basic Arduino issues - Types of IoT interaction - Machine to Machine interaction (M2M).

UNIT V	CONTROL & SUPERVISORY LEVEL OF AUTOMATION	9

Theory

Programmable logic controller (PLC) - Real-time control system - Supervisory Control & Data Acquisition (SCADA) - HMI in an automation process - ERP & MES - Case study: Health monitoring - IoT smart city - Smart irrigation - Robot surveillance.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Alasdair Gilchrist,'Industry 4.0: The Industrial Internet of Things', 2017, Apress Publication, 1st Edition.
2.	Sudip Misra, Chandana Roy, Anandarup Mukherjee, 'Introduction to Industrial Internet of Things and Industry 4.0', 2020, CRC Press, 1st Edition.

REFERENCE BOOKS

1.	Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, 'Industrial Internet of Things: Cyber manufacturing Systems', (Springer), 2017

2.	Yasser Ismail,'Internet of Things (IoT) for Automated and Smart Applications', 2019, IntechOpen, 1st Edition.
3.	Ismail Butun , "Industrial IoT: Challenges, Design Principles, Applications, and Security", Springer International Publishing AG,2020,1st Edition.
4.	Ioana Culic, Alexandru Radovici, Cristian Rusu, 'Commercial and Industrial Internet of Things Applications with the Raspberry Pi: Prototyping IoT Solutions', Springer India, 2022, 1st Edition.
5.	Giacomo Veneri, Antonio Capasso, 'Hands-On Industrial Internet of Things: Create a powerful Industrial IoT Infrastructure using Industry 4.0',Packt Publishing, 2018, 1st Edition.

COURSE OUTCOMES

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

CO's	STATEMENTS	RBT LEVEL
1	Analyze the growth of Industrial revolution and understand the the basic concepts and Architectures of Internet of Things.	4
2	Analyze communication topologies of IIOT.	4
3	Investigate the data types of IIOT.	4
4	Develop methodology of retrieving data from Web.	4
5	Examine the control concepts and supervisory control in IIOT.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2					1		2		3		2
2	3	3	2	3				1		2		3		2
3	3	3	2					1		2		3		2
4	3	3	2	3				1		2		3		2
5	3	3	2	3				1		2		3		2

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

VD22609	SMART SWITCHGEAR AND PROTECTION	L T P C
		1 0 2 2

COURSE OBJECTIVES

- To know the components of smart relays
- To comprehend the concepts of smart protective relays.
- To understand the protection and coordination of smart relays.
- To apply the concepts of synchrophasors

UNIT I	INTRODUCTION	9

Basic Components of Smart Relays with block diagram - Microprocessor based relaying – Phasor Measurement Unit (PMU) based supervised protection - Wide area protection and measurement.

UNIT II	SMART PROTECTION RELAYS - I	9

Classification of smart protective relays - Adoptive relaying - Relay algorithms - Comparison of smart relays with previous generation relays.

UNIT III	SMART PROTECTION RELAYS - II	9

Introduction to Intelligent Electronic Devices (IED) – Smart protection of Generators, Induction motors, Transformers and Transmission lines.

UNIT IV	PROTECTION AND COORDINATION OF SMART RELAYS	9

Smart protection of an interconnected system - Flowchart of Primary/Backup relay pairs - Flowchart of Time Multiplier Setting – Case studies based on existing power system network

UNIT V	SYNCHROPHASORS APPLICATIONS	9

Synchrophasor fundamentals – Measurement Principles and Components – Synchrophasor Metrices – Importance of Phase angle differences and PMU location.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Badri Ram, B.H. Vishwakarma, 'Power System Protection and Switchgear', Tata McGraw Hill Education Pvt. Ltd., 2022, 3rd Edition.
2.	T.S. Madhava Rao, 'Power System Protection: Static Relays', Tata McGraw Hill Education Pvt. Ltd., 2017, 2nd Edition.

REFERENCE BOOKS

1.	L. P. Singh, 'Digital Protection -Protective Relaying from Electromechanical to Microprocessor' New Age International Publishers, 2017, 2nd Edition.
2.	Bhavesh Bhalja, R. P. Maheshwari, Nilesh G. Chothani, 'Protection and Switchgear, Oxford University Press, 2018, 2nd Edition.
3.	Synchronized Phasor Measurements and their Applications, A. G. Phadke and J. S. Thorp,Springer, 2008.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to:		
COs	**STATEMENTS**	**RBT LEVEL**
1	Understand various smart protective relays of a power system.	2
2	Comprehend the smart relaying principles in comparison with traditional electro-mechanical relays.	2
3	Analyze smart protection schemes for power system apparatus.	4
4	Examine protection and coordination of smart relays.	4
5	Evaluate the concept of synchronizing phasor measurement units.	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2		2		2		1		1		3		3
2	3	2	1	2	2	2	1	1	1	1		2	3	3
3	3	3	2	2	2	2	2	1	1	1	1	2	2	3
4	3	3	2	2	2	2	1	1	1	1	1	3	3	3
5	3	3	2	2	3	2	1	1	1	1		2		3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

VD22610	CONTENT WRITING	LT P C
		1 0 2 2

COURSE OBJECTIVES

- To introduce learners to the basic concepts of Content Writing
- To sensitize them to the various styles and techniques of writing and editing
- To increase employability of the learners
- To create industry-academia interface through institutional support

UNIT I	BASICS OF CONTENT WRITING	9

The Concept of Content Writing and its relevance - Role and Functions of Content Writers - Print and Web Content Writing - Scope and Types of Content Writing -Principles and processes of content writing.

UNIT II	TYPES OF CONTENT WRITING	9

Editing and Proof-Reading— company style sheet, grammar, copy flow, restructuring, market research. Writing Styles - Non-fiction (Essays, Reports), Advertising, Newspapers. Writing blogs, case studies, white papers. Corporate Communications - Writing for business to business (B2B), business to consumer (B2C), press releases, newsletters – focus on language, jargon, writing style, target audience, formal and informal language.

UNITIII	VISUAL AND INTERACTIVE CONTENT	9

Visual Content - Infographics- Importance and relevance – Images - Screenshots - Videos, Memes, GIFs, 30 degree videos - Product Demonstrations. Interactive Content - Quizzes. Polls, Interactive white papers.

UNIT IV	TOOLS OF THE TRADE I	9

Free tools and paid tools - Social Media - Understanding the basics of social media - Understanding social media content writing - Understanding PR.

UNIT V	TOOLS OF THE TRADE II	9

Plagiarism laws in Content Writing - What is plagiarism, rules on plagiarism - How to write plagiarism-free copies.

TOTAL PERIODS: 45

REFERENCE BOOKS

1.	Feldar, Lynda. 'Writing for the Web: Creating Compelling Web Content Using Words, Pictures, and Sound'. New Riders, CA, USA. ISBN-13: 978-0321794437, ISBN10: 9780321794437
2.	James, Anthony.'Blog Writing: The Content Creation Blueprint. Amazon digital services' LLDKDP print US, 2018
3.	Robinson Joseph. 'Content Writing Step-by-step. Amazon digital services' LLC--KDP print US, 2020. ISBN: 9798603871929.
4.	Redish, Janice, Morgan Kaufmann, 'Letting Go of The Words: Writing Web Content That Works'. ISBN: 0123859301

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Comprehend the basic concepts of Content Writing	2
2	Apply the knowledge of various styles and techniques of writing and editing	3
3	Nourishment of the creative skills	3
4	Enhancement of the employability skills	4
5	Creation of industry-academia interface through institutional support	6
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1		1				1		1		2		2		
2		2		2		1		1		2		2		
3		2	1			1		1	1	2		2		
4		2	1		2	1	1	3	2	2		2		
5		2	2		2	1	1	1	2	2	2	1		

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

VD22611	INTELLECTUAL PROPERTY RIGHTS	L T P C
		2 002

COURSE OBJECTIVES

- To understand the process and need for protecting technology innovations through Intellectual Property Rights.
- To disseminate knowledge on patents, patent regime in India and abroad and registration aspects,
- patent drafting and searching
- To aware about current trends in IPR and Government steps in fostering IPR.

UNIT I	TECHNOLOGICAL INNOVATIONS	6

The process of technological innovation - factors contributing to successful technological innovation - the need for creativity and innovation - problem solving and creativity through brain storming - different techniques - Selection criteria - screening ideas for new products - evaluation techniques. Protection of IP as a factor in R&D and few case studies.

UNIT II	INTRODUCTION TO IPR & RELATED AGREEMENTS AND TREATIES	6

Types of Intellectual Property Rights: patents, trademarks, copyright and related rights, industrial design, traditional knowledge, geographical indications, Indian Patent Act 1970 & its recent amendments, IPR in India and abroad, case studies.

UNIT III	BASICS OF PATENTS AND CONCEPT OF PRIOR ART	6

Introduction to Patents:types of patent applications: ordinary, PCT, conventional, divisional and patent of addition; specifications: provisional and complete; prior art,patent databases; searching international databases; country-wise patent searches, USPTO, EPO, PATENT Scope (WIPO), IPO, etc.), hands-on-training on patent search &patent drafting.

UNIT IV	PATENT FILING PROCEDURES	6

Forms, fees and time frame, precautions while patenting – disclosure/non-disclosure,patent filing procedures in india, PCT filing procedure, status of the patent applications filed,financial assistance for patenting - case studies on patent filing.

UNIT V	PATENT RIGTS AND NEW DEVELOPMENTS IN IPR	6

Scope of patent rights, patent licensing and agreement, transfer of technology, new developments in IPR,administration of patent system, government steps infostering IPR, patent infringement- meaning, scope, litigation, case studies on patent infringement.

TOTAL PERIODS: 30

TEXT BOOKS

1.	Ramappa, T. 'Intellectual Property Rights Under WTO: Task before India', Wheeler Publisher 2000.
2.	Lexis Nexis, 'Patents Act, 1970 along with Rules, 2003 Bare Act 2024', Universal Publisher 2024.

REFERENCE BOOKS

1.	Adair, J. 'Effective Innovation', Macmillan Publishing, 2003, 1st Edition.
2.	Robert P. Merges, Peter S. Menell and Mark A. Lemley, 'Intellectual Property in New Technological Age', Aspen Publishers, 2016.
3.	Nystrom, H, 'Creativity and Innovation', John Wiley & Sons, 1996, 2nd Edition.
4.	Nithyananda, K V, 'Intellectual Property Rights: Protection and Management. India IN', Cengage Learning India Private Limited, 2019.

5.	Neeraj, P, and Khusdeep, D, 'Intellectual Property Rights India IN', PHI learning Private Limited, 2014

COURSE OUTCOMES

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

CO's	STATEMENTS	RBT LEVEL
1	Interpret the process of problem solving through technological innovations.	4
2	Infer the appropriate IPR elements for protecting intellectual property.	4
3	Analyze the methodology of prior art search and patent drafting.	4
4	Develop the procedure for filing patent.	5
5	Examine the scope of patent rights for licensing and transfer of technology	5

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3		3	3	3	3			3		3
2	3	3	2			3						3		3
3	3	3	2		3	3		3	3			3		3
4	3	3	2			3		2	2	2		3		3
5	3	3	3	2	3	3	2	3	3	3		3		3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

VD22612	BLOCK CHAIN TECHNOLOGY	L T P C
		1 0 2 2

COURSE OBJECTIVES

- To provide students with a comprehensive understanding of block chain technology.
- To covering its foundational concepts, underlying principles, and real-world applications.
- To analyze, develop, and implement block chain solutions through a combination of lectures, case studies, and hands-on exercises, students will gain practical knowledge and skills

UNIT I	UNDERSTANDING BLOCK CHAIN FUNDAMENTALS	9

Introduction to Block chain Technology - Historical Context and Evolution of Block chain - Core Components of Block chain: Blocks, Chains, and Nodes - Consensus Mechanisms: Proof of Work, Proof of Stake, and Others - Cryptography Basics in Block chain: Hash Functions, Digital Signatures, and Public/Private Keys

UNIT II	BLOCK CHAIN ARCHITECTURE AND PROTOCOLS	9

Block chain Architecture Models: Public, Private, and Consortium - Ethereum Platform: Smart Contracts and Decentralized Applications (DApps) - Hyperledger Framework: Fabric, Sawtooth, and Composer - Other Block chain Platforms and Protocols - Interoperability and Scalability Challenges

UNIT III	APPLICATIONS OF BLOCK CHAIN TECHNOLOGY	9

Cryptocurrencies: Bitcoin, Ethereum, and Altcoins - Tokenization and Digital Assets - Decentralized Finance (DeFi) and Smart Contracts - Supply Chain Management and Traceability - Identity Management and Authentication Systems

UNIT IV	BLOCK CHAIN SECURITY AND PRIVACY	9

Security Threats and Vulnerabilities in Block chain - Secure Development Best Practices - Privacy Techniques: Zero-Knowledge Proofs and Homomorphic Encryption - Regulatory Considerations and Compliance Challenges - Auditing and Governance in Block chain Networks

UNIT V	HANDS-ON BLOCK CHAIN DEVELOPMENT	9

Setting up Block chain Development Environment - Smart Contract Development with Solidity (Ethereum) - Building Decentralized Applications (DApps) - Interacting with Block chain Networks using Web3.js - Case Studies and Practical Exercises

TOTAL PERIODS: 45

REFERENCE BOOKS

1.	Imran Bashir, 'Mastering Block chain'Packt Publisher, Aug 2020, 3rd Edition.
2.	Elad Elrom, 'The Block Chain Developer', Springer Publisher, Dec 2021, 1st Edition.
3.	Sudeep Tanwar, 'Block Chain Technology from Theory to Practice', Springer Publisher, 2022.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	To recognize the importance of block chain technology.	4
2	To explain the challenges and design issues in bit coin technology.	4
3	To categorize the platforms developed for block chain.	4
4	To use appropriate techniques to study impacts of industry	4
5	To use the block chain resources and projects.	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	3	3	3	2	3	2	2		2	2		3	3	3
2	3	3	3	2	3	2	2		2	2		3	3	3
3	3	3	3	2	3	2	2		2	2		3	3	3
4	3	3	3	2	3	2	2		2	2		3	3	3
5	3	3	3	2	3	2	2		2	2		3	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

VD22613	DIGITAL TWIN AND DEEP LEARNING	L T P C
		1 0 2 2

COURSE OBJECTIVES

- To understand the evolution of digital twin
- To understand the enabling technologies for digital twin
- To understand how to build a digital twin
- To study the basics of deep learning to apply it to a digital twin
- To understand digital twin as an interdisciplinary technology

UNIT I	BASIC CONCEPTS OF DIGITAL TWINS	9

Evolution of Pairing, Definition and Features of Digital Twins, Digital Twin Timeline, Digital Thread, Digital Shadow, Building Blocks of Digital Twins, Digital Twin Technology Drivers & Enablers, Types of Digital Twin, Characteristics of a Good Digital Twin

UNIT II	DIGITAL TWINS IN MANUFACTURING,	9

Digital Twins in Manufacturing, Digital Twins Built on IoT Platform, Performance of Digital Twin, Complexity and Scale of Digital Twins, Executable Digital Twins, Functional Digital Twins Example, Digital Twins and the Automotive Industry

UNIT III	DIGITAL TWINS PLATFORM ECOSYSTEM	9

Digital Twins Concept, Digital Twins Implementation Guidelines, Digital Twins Implementation, Digital Twins Challenges and Risks, Insights from Siemens, Evolving Digital Twins Ecosystems, Business Advantages of Digital Twins.

UNIT IV	DEEP LEARNING	9

Introduction to Neural Network - Perceptron, Multi-layer Perceptron, Hidden Units, Architecture Design, Types of Neural Networks, Back Propagation Algorithms-Stochastic gradient decent and its variants, Convolutional Neural Networks - Convolution operation, pooling, Activation functions.

UNIT V	DIGITAL TWIN AND DEEP LEARNING	9

Enabling technologies for Digital Twin - Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL), Big Data Analytics, Internet of Things (IOT), Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), Cloud Computing Services (CCS) - Deep learning in digital twin technology - GANS and VAE

TOTAL PERIODS: 45

TEXT BOOKS

1.	Digital Twin: Possibilities of the new Digital twin technology, Anand Iyer, 2017, 35 Pages.
2.	Advances in Computers, The Digital Twin Paradigm for Smarter Systems and Environments: The Industry, Pethuraj& Preetha Evanjaline, ELSEVIER, pages 257, ISBN 978-0-12-818756-2, ISSN 0065- 2458

REFERENCE BOOKS

1.	Digital Twin Driven Smart Design by Fei Tao, Ang Liu, Tianliang Hu, A.Y.C. Nee, ELSEVIER, ISBN 978-0-12-818918-4.
2.	Handbook Of Digital Enterprise Systems: Digital Twins, Simulation and Ai, by Wolfgang Kühn, world scientific publishing co., ISBN 978-981-120-073-1
3.	Digital Twin Driven Smart Manufacturing, By Fei Tao, Meng Zhang, A.Y.C. Nee, ISBN 978-0-12- 817630-6, ELSEVIER

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Explain the basics of Digital Twin	3
2	Identify various enabling technologies of digital twin.	4
3	Implement a Digital Twin at a small scale	4
4	Apply the integration of AI to digital twin	4
5	Apply the digital twin technology in interdisciplinary application.	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3		2		2	1	2	3	2	2	2
2	3	3	3	3		2		2	1	2	3	2	2	2
3	3	3	3	3		2		2	1	2	3	2	2	2
4	3	3	3	3		2		2	1	2	3	2	3	3
5	3	3	3	3		2		2	1	2	3	2	3	3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

OPEN ELECTIVES OFFERED IN ODD SEMESTER

OE22601	BIOMEDICAL ENGINEERING	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To learn the various physiological systems and transducers to build a biomedical system.
- To gain knowledge about the various parameters both electrical and non electrical and the methods of recording and imaging analysis.
- To explore the various assist devices and recently developed diagnostic and therapeutic techniques.
- To understand the handling of biomedical waste

UNIT I	FUNDAMENTALS OF BIOMEDICAL ENGINEERING	9

Cell and its structure – Resting and Action Potential – Nervous system and its fundamentals – Cardiovascular systems – Respiratory systems. Basic components of a biomedical system– Physiological signals and transducers – Transducers – Selection criteria – Piezo electric, ultrasonic transducers – Temperature measurements – Fiber optic temperature sensors.

UNIT II	NON ELECTRICAL AND ELECTRICAL PARAMETER MEASUREMENTS	9

Measurement of blood pressure – Cardiac output – Heart rate – Heart sound – Pulmonary function measurements – Spirometer –Plethysmography – Blood Gas analyzers, pH of blood – Measurement of blood pCO2, pO2, finger-tip oximeter – Introduction to polarizable and nonpolarizable electrodes - Types of Electrodes – Equivalent circuit – ECG – EEG – EMG – ERG – Lead systems and recording methods. Electrical safety in medical environment, shock hazards – leakage current.

UNIT III	IMAGING MODALITIES AND ANALYSIS	9

X-ray machine – Computer tomography – Magnetic resonance imaging – Nuclear medicine – Single photo emission computer tomography – Positron emission tomography – Ultrasonography – Endoscopy – Thermography.

UNIT IV	LIFE ASSISTING, THERAPEUTIC, ROBOTIC DEVICES AND ETHICS	9

Pacemakers – Defibrillators - Ventilators - Nerve and muscle stimulators, Diathermy - Heart Lung machine - Audio meters - Dialyzers, Lithotripsy - Therapeutic Devices – Infant Incubators – Surgical Instruments – Nano Robots – Robotic surgery - Keyhole Surgery -Rehabilitation engineering - Clinical engineering - Moral and ethical considerations, human and animal research, consent, and death.

UNIT V	BIOMEDICAL WASTE MANAGEMENT	9

Categories and classification of biomedical wastes, hazards of biomedical waste, need for disposal of biomedical waste, waste minimization, waste segregation and labelling, waste handling and disposal methods.

TOTAL PERIODS: 45

TEXT BOOKS

1.	John G. Webster, 'Medical Instrumentation Application and Design', John Wiley andsons, New York, 2010, 4th Edition.
2.	Khandpur R.S, 'Handbook of Biomedical Instrumentation', Tata McGraw-Hill, New Delhi, 2014, 3rd Edition.

REFERENCE BOOKS

1.	Leslie Cromwell, 'Biomedical Instrumentation and Measurement', Prentice Hall ofIndia, New Delhi, 2007.

2.	Arumugam M, 'Biomedical Instrumentation', Anuradha Agencies Publishers, Chennai, 2010.
3.	R. Brunner, 'Medical Waste Disposable' Handbook, Incinerated Consultant Incorporated, Virginia, 2008, 2nd Edition.
4.	Joseph J. Carr and John M. Brown,'Introduction to Biomedical Equipment Technology', John Wiley and sons, 4th edition, New York, 2019, 4th Edition.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Understand the physiology of biomedical system and related transducers	3
2	Comprehend measurement and processing of physiological electrical and non-electrical parametersand related electrical safety.	3
3	Discuss and analyze physiological conditions using imaging techniques in medical diagnostics.	4
4	Apply clinical engineering techniques to create life assisting and therapeutic equipment.	4
5	Categorize various biomedical waste and related hazards, and evaluate waste management and disposal.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3		3	3	2				3	2	
2	3	3	3	3		3	3	2				3	3	
3	3	3	3	3		3	3	2				3	3	
4	3	3	3	3		3	3	2				3	2	
5	3	3	3	3		3	3	2				3	2	

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

OE22603	CONTROL SYSTEM ENGINEERING	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand the use of transfer function models for physical systems analysis and introduce the control system components
- To provide adequate knowledge in the time response of systems and steady state error analysis
- To accord basic knowledge in obtaining the open loop and closed loop frequency responses of systems
- To introduce stability analysis and its determination by various methods.
- To introduce compensators and controllers and its design.

UNIT I	INTRODUCTION AND TRANSFER FUNCTION MODELLING	10

Open loop and closed loop systems – Examples, Control system components. Transfer function of physical systems: Mechanical systems - Translational and Rotational systems, Electrical network, Thermal and hydraulic systems. Transfer function of DC servomotor, AC servomotor, Transfer function of overall systems. Block diagram-reduction techniques. Signal flow graphs – Mason's gain formula.

UNIT II	TIME RESPONSE ANALYSIS	08

Standard Test signals –Time response of zero, first and second order system, Performance criteria, Type of systems. Steady state error constants – position, velocity and acceleration error constants. Generalized error series – Feedback characteristics of control systems.

UNIT III	FREQUENCY RESPONSE ANALYSIS	10

Frequency domain specifications – peak resonance, resonant frequency, bandwidth and cut-off rate, correlation between time and frequency responses for second order systems. Polar plot, Bode plot – Gain Margin and Phase Margin.

UNIT IV	STABILITY OF SYSTEMS	10

Characteristic equation – Location of roots of characteristic equation – Absolute stability and Relative stability. Routh Hurwitz criterion of stability – Necessary and sufficient conditions - Nyquist Stability - Principle of argument – Nyquist path – Nyquist stability criterion and determination of stability – Assessment of relative stability - Stability analysis using Bode Plot. Root locus concept, Rules for construction of Root Locus.

UNIT V	COMPENSATORS AND CONTROLLERS	07

Introduction to Compensators - Lag, Lead and Lag-Lead CompensatorsTransfer function and Characteristics – Controllers - P, PI and PID control modes.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Gopal M, 'Control Systems – Principles and Design', Tata McGraw-Hill, New Delhi, 2013.
2.	Norman S Nise, 'Control System Engineering ', John Wiley & Sons, New Delhi, 2013.

REFERENCE BOOKS

1.	Benjamin Kuo, 'Automatic Control Systems', Prentice Hall of India, New Delhi, 2010.
2.	Dazzo J J, Houpis C H, 'Linear Control System Analysis and Design with MATLAB', McGraw-Hill, New York, USA, 2003, 5th Edition.
3.	Ogatta K, 'Modern Control Engineering', Prentice Hall of India, New Delhi, 2013. 4. Richard C. Dorf, Robert H. Bishop, "Modern Control Systems", Prentice Hall, USA, 2011, 12th Edition.
4.	S.Palani, AnoopK.Jairath, 'Automatic Control Systems including MATLAB',

	ANEBooks,2013.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Derive the transfer functions for mechanical and electrical systems.	4
2	Obtain the steady state and generalized error constants for various test signals.	4
3	Sketch Bode and Polar plots for a transfer function.	5
4	Determine the stability of a system by Routh-Hurwitz -Nyquist criteria – Root Locus – Bode plot.	5
5	Design a compensator for a transfer function and design controllers using control modes	5

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3					2			3		
2	3	3	3	3					2			3		
3	3	3	3	3					2			3		
4	3	3	3	3					2			3		
5	3	3	3	3					2			3		

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

OE22605	MICRO AND SMART GRID	L T P C
		30 0 3

COURSE OBJECTIVES

- Develop a conceptual introduction to microgrids and their control.
- Develop a conceptual introduction to smart grids and their control.

UNIT I	INTRODUCTION OF A MICROGRID AND SMART GRID	9

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

Smart Grid: Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart Grid drivers, Functions, opportunities, challenges and Benefits, AC and DC microgrid, Difference between conventional & smart Grid, National and International Initiatives in Smart Grid -Implementation of smart grid technologies in India.

UNIT II	CONTROL AND OPERATION OF MICROGRID	9

Modes of operation and control of microgrid: grid-connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active, and communication-based techniques, microgrid communication infrastructure, Power quality issues in microgrids, regulatory standards, Microgrid economics, Introduction to smart microgrids.

UNIT III	DISTRIBUTION GENERATION TECHNOLOGIES	9

Introduction to Distribution Energy Sources, Renewable Energy Technologies – Microgrids – Storage Technologies –Electric Vehicles and plug–in hybrids – Environmental Impact and Climate Change – Economic Issues.

UNIT IV	SMART MEASURING DEVICES AND SMART METERING	9

Phasor Measurement Unit (PMU), Limitations of RTU, GPS Time Synchronization, Location & Placement, Features - Wide Area Monitoring Systems (WAMS) - Sub-station Automation Systems (SAS) - Distribution Automation Systems (DAS). Introduction to Smart Meters, Advanced Metering Infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives

UNIT V	HIGH-PERFORMANCE COMPUTING	9

Local Area Networks (LAN), House Area Networks (HAN), Wide Area Networks (WAN), Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Types of cyber-attacks in smart grid, Prevention of cyber-attacks by means of cyber security in smart grids.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, ISBN: 9780-470-62761-7, Wiley
2.	James Momoh, Smart Grid: Fundamentals of Design and Analysis, ISBN: 978-0470-88939-8, Wiley
3.	S. Chowdhury, S.P. Chowdhury and P. Crossley, Microgrids and Active Distribution Networks, ISBN 978-1-84919-014-5, IET, 2009

REFERENCE BOOKS

1.	Vehbi C. Gungor, Dilan Sahin, Taskin Kocak, Salih Ergut, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, Smart Grid Technologies: Communication Technologies and

	Standards IEEE Transactions on Industrial Informatics, Vol. 7, No. 4, November 2011.
2.	. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang "Smart Grid – The New and Improved Power Grid: A Survey", IEEE Transaction on Smart Grids.
3.	S. Borlase, "Smart Grids, Infrastructure, Technology and Solutions", CRC Press, 2013, 1st Edition.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Differentiate conventional grids, microgrids, and smart grids.	4
2	Select a suitable control scheme, communication, and protection of microgrids.	4
3	Understand the role of distribution generation in a smart grid system	4
4	Acquire Knowledge of advanced metering infrastructure and analyzing hardware implementation.	4
5	Identify suitable computer network for smart grid applications	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3			2	3	3	2		2	2				
2	3	2	3	3	3	3	2		2	2				
3	3	2	3	3	3	3	2		2	2				
4	3	2	3	3	3	3	3		2	2				
5	3		2	3	3	3			2	2				

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

OE22607	ELECTRIC VEHICLE TECHNOLOGY	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To introduce the architecture of electric vehicles and fundamentals of vehicle dynamics, and powertrain components specific to electric and hybrid electric vehicle
- To understand the principles and speed control methods of electric drive motors used in EVs.
- To impart the knowledge on the energy storage technologies, charging and battery management technologies in EV.

UNIT I	INTRODUCTION TO ELECTRIC AND HYBRID VEHICLES	9

Electric and Hybrid vehicle components – Configurations of Electric vehicles and Hybrid electric vehicles – Plug-in hybrid electric vehicle – Fuel cell electric vehicle – Challenges and benefits of EVs - Current scenario of EV and HEVs in market.

UNIT II	POWER TRAIN COMPONENTS AND ITS SIZING	9

Fundamentals of vehicle dynamics: Vehicle resistance and dynamic equation – Power train components – Gears, Clutches, Differential, Transmission and Vehicle Brakes – EV and HEV power train sizing.

UNIT III	ENERGY SOURCE TECHNOLOGY	9

Energy storage technologies in electric and hybrid electric vehicles – battery, flywheel, fuel cell, ultra-capacitors- Hybridization of different energy storage devices – Ragone Plot – Range prediction of batteries.

UNIT IV	MOTOR DRIVE TECHNOLOGY	9

Comparison of speed torque characteristics of IC engine and Electric motor – Requirements of EV motor compared to industrial motor – Chopper control of DC motor, Vector control of Induction motor drive, Control of Switched reluctance motor, Brushless DC motor and Permanent Magnet Synchronous motor – Choice of electric motors for EVs.

UNIT V	BATTERY CHARGING TECHNOLOGY	9

Charging schemes for EV: Normal charging, opportunity charging and fast charging – Charging algorithms – On-board and Off-board chargers – Wireless power transfer schemes: Inductive and Capacitive – Vehicle to grid technology – Battery Management System: SoC estimation and Cell balancing.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Iqbal Hussein, 'Electric and Hybrid Vehicles: Design Fundamentals', CRC Press, 2021, 3rd Edition.
2.	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2018, 3rdEdition.

REFERENCE BOOKS

3.	James Larminie, John Lowry, 'Electric Vehicle Technology Explained', Wiley, 2012, 2ndEdition.
4.	C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001.
5.	Sheldon S. Williamson, 'Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles', Springer, 2013.
6.	Chris Mi, M. Abul Masrur, 'Hybrid Electric Vehicles Principles and applications with practical perspectives', Wiley Publication, 2017.
7.	NPTEL lecture on 'Electric Vehicles Part 1'.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
CO's	**STATEMENTS**	**RBT LEVEL**
1	Comprehend configurations, challenges, and benefits of electric and hybrid vehicles	2
2	Apply knowledge of powertrain sizing techniques to components of electric and hybrid electric vehicles.	3
3	Analyze the characteristics and advantages of various energy storage systems and apply range prediction methods to assess the performance and endurance of battery systems	4
4	Analyze the control strategies and operational characteristics of electric propulsion drive for EV applications.	4
5	Acquire knowledge on energy management strategies and charging technologies in EVs	3
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	2	2		1			2	2		2		
2	3	3	3	3		2	2		2	2		3		
3	3	3	3	3		2	2		2	2		3		
4	3	3	3	3		2	2		2	2		3		
5	3	3	3	2		2	2		2	2		3		

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

EE22609	ENERGY CONSERVATION PRACTICES	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To introduce energy audit and management in electrical system.
- To gain knowledge about energy management approaches for motor and lighting loads.
- To investigate energy management solutions for buildings.
- To elucidate the energy auditing procedure.

UNIT I	BASIC PRINCIPLES OF ENERGY AUDIT AND MANAGEMENT	9

Energy audit – Definitions – Concept – Energy index – Cost index – Pie charts –Sankey diagrams – Load profiles – Energy conservation schemes and energy saving potential – Numerical problems –Principles of energy management – Initiating, planning, controlling, promoting, monitoring, reporting – Energy manager – Qualities and functions.

UNIT II	LIGHTING	9

Definition of terms and units –Luminous efficiency – Polar curve – Calculation of illumination level – Illumination of inclined surface to beam –Luminance or brightness – Types of lamps – Types of lighting – Electric lighting fittings (luminaries) – Flood lighting – White light LED– Energy conservation measures.

UNIT III	ENERGY MANAGEMENT FOR MOTOR LOADS	9

Load scheduling/shifting, Motor Drives- motor speed control, Development of energy efficient motors, techniques for improving energy efficiency, necessity for load matching and selection of motors for constant and variable loads

UNIT IV	ENERGY MANAGEMENT IN BUILDINGS	9

Energy conservation building code (ECBC) - Guidelines on heating ventilation, Air conditioning system, water pumping system, Uninterruptible power supply, escalators and elevators - Energy efficiency measures in buildings - Energy performance assessment and energy savings measures of DG sets.

UNIT V	ENERGY AUDIT	9

Definition - Need for energy audit - Types of energy audit and approach - Benchmarking - Bureau of energy efficiency regulation - Energy monitoring and targeting - Energy management information system (EMIS).

TOTAL PERIODS: 45

TEXT BOOKS

1.	Hand Book of Energy Audit by Sonal Desai- Tata McGraw hill
2.	Energy efficiency in electrical utilities, 2015, By Bureau of Energy Efficiency, Ministry of Power, India.

REFERENCE BOOKS

1.	Electric Energy Utilization and Conservation by S C Tripathy, TMH publishing company Ltd. New Delhi
2.	Energy management by Paul o' Callaghan, Mc–Graw Hill Book company, 1998, 1st Edition.
3.	Energy management hand book by W.C. Turner, John Wiley and sons
4.	Energy management and conservation – KV Sharma and P. Venkata Seshaiah-I K International Publishing House Pvt. Ltd, 2011.
5.	Energy efficiency in electrical utilities, 2015, By Bureau of Energy Efficiency, Ministry of Power, India.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to:		
COs	**STATEMENTS**	**RBT LEVEL**
1	Proficiency in Energy Auditing and Management	3
2	Acquired knowledge in electric lighting systems	3
3	Capable of analyzing Motor Load Energy Management	4
4	Proficient in analyzing building energy management	4
5	Competent in energy auditing	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3		3	3	2	3		3	3		
2	3	3	3	3	2	3	3	2	3		3	3		
3	3	3	3	3	2	3	3	2	3		3	3		
4	3	3	3	3	2	3	3	2	3		3	3		
5	3	3	3	3	3	3	3	2	3		3	3		

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

OE22611	INDUSTRIAL ELECTRICAL SYSTEMS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand the various electrical system components
- To know the residential and commercial electrical systems
- To study the illumination systems
- To discuss about the industrial electrical systems

UNIT I	ELECTRICAL SYSTEM COMPONENTS	9

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

UNIT II	RESIDENTIAL AND COMMERCIAL ELECTRICAL SYSTEMS	9

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

UNIT III	ILLUMINATION SYSTEMS	9

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

UNIT IV	INDUSTRIAL ELECTRICAL SYSTEMS – I	9

HT connect ion, industrial substation, Transformer select ion, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.

UNIT V	INDUSTRIAL ELECTRICAL SYSTEMS – II	9

DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.

TOTAL PERIODS: 45

TEXT BOOKS

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

REFERENCE BOOKS

1.	S. Singh and R. D. Singh, ‘Electrical estimating and costing’, Dhanpat Rai and Co., 1997.
2.	Web site for IS Standards: https://bis.gov.in
3.	H. Joshi, ‘Residential Commercial and Industrial Systems’, McGraw Hill Education, 2008.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
CO	**STATEMENTS**	**RBT LEVEL**
1	Examine the electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbols and drawings, SLD.	4
2	Analyze the various components of industrial electrical systems.	5
3	Evaluate, design and analyze the illumination systems for residential and commercial applications.	4
4	Explain about various Industrial Electrical Systems	4
5	Study on various electrical system components	4
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

CO	**PO**												**PSO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	3	3		3	1	1	3	2	3	3		
2	3	2	3	3	2	3	1	1	3	2	3	3		
3	3	2	3	3	2	3	1	1	3	2	3	3		
4	3	2	3	3	2	3	1	1	3	2	3	3		
5	3		3	2		3	1	1	3	2	3	3		

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

OE22613	AUTONOMOUS VEHICLES	L T P C
		3 00 3

COURSE OBJECTIVES

- To understand the fundamental principles and components of autonomous vehicle systems, and compare different sensor modalities used in autonomous vehicles.
- To develop algorithms for perception tasks such as object detection, classification, and tracking.
- To design and implement decision-making algorithms for autonomous navigation and path planning.
- To evaluate and optimize control systems for vehicle dynamics and trajectory tracking.
- To assess safety and ethical considerations in autonomous vehicle design and deployment.

UNIT I	INTRODUCTION TO AUTONOMOUS VEHICLES AND SENSING	9

Overview of autonomous vehicle technology – Historical perspective and current trends – Key components and subsystems of Avs – Ethical and societal implications.

Sensor types and their characteristics (LiDAR, radar, cameras, etc.) – Sensor fusion techniques – Calibration and synchronization – Perception algorithms.

UNIT II	DECISION MAKING AND PLANNING	9

Motion planning algorithms – A*, RRT*(Rapidly-exploring Random Tree), MPC(Model Predictive Control) – Behavior-based and rule-based decision-making – Predictive modeling and risk assessment – Human-robot interaction considerations.

UNIT III	CONTROL SYSTEMS FOR AUTONOMOUS VEHICLES	9

Vehicle dynamics and modelling – PID control and its variants – Nonlinear control-techniques – Adaptive and robust control strategies.

UNIT IV	LOCALIZATION AND MAPPING	9

Simultaneous Localization and Mapping (SLAM) – Global and local localization methods – Map representations (grid-based, feature-based, etc.) – Visual odometry and dead reckoning.

UNIT V	AUTONOMOUS VEHICLE APPLICATIONS AND SAFETY AND SECURITY	9

Urban mobility and transportation – Agriculture and mining – Logistics and delivery – Autonomous racing and gaming – Functional safety standards (ISO 26262) – Safety-critical systems design – Cybersecurity considerations – Fault detection and diagnostics.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Nikolaus Correll, Bradley Hayes, and Amirhossein Memarzadeh, 'Introduction to Autonomous Robots: Mechanics, Sensors, Actuators, and Algorithms', MIT Press, 2022.
2.	Lounis Adouane, A K Peters, 'Autonomous Vehicle Navigation: From Behavioral to Hybrid Multi-Controller Architectures', CRC Press, 2016.

REFERENCE BOOKS

1.	James M. Anderson, Nidhi Kalra, Karlyn D. Stanley, and Paul Sorensen, 'Autonomous Vehicle Technology: A Guide for Policymakers', RAND Corporation, 2016.
2.	R. Kelly, V. Santibañez, and A. Loria, 'Control of Robot Manipulators in Joint Space, Springer, 2005.
3.	Hermann Winner, Stephan Hakuli, Felix Lotz, and Christina Singer, 'Handbook of Driver Assistance Systems: Basic Information, Components and Systems for Active Safety and Comfort', Springer Nature, 2016.

4.	Markus Maurer, J. Christian Gerdes, Barbara Lenz, and Hermann Winner, 'Autonomous Driving: Technical, Legal and Social Aspects', Springer, 2016.
5.	Howie Choset, Kevin M. Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia E. Kavraki, and Sebastian Thrun, 'Principles of Robot Motion: Theory, Algorithms, and Implementations', Bradford Books, 2005.

COURSE OUTCOMES

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

COs	**STATEMENTS**	**RBT LEVEL**
1	Demonstrate a comprehensive understanding of autonomous vehicle technology and its underlying principles.	3
2	Design and implement algorithms for perception, decision-making, and control in autonomous systems.	4
3	Evaluate and address safety, ethical, and societal implications associated with autonomous vehicles.	4
4	Apply Simultaneous Localization and Mapping, global and local localization methods, map representations, visual odometry, and dead reckoning techniques.	4
5	Evaluate autonomous vehicle applications in various sectors, ensuring safety, cybersecurity, and fault detection.	5

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3		3		3	1	2	2		3		3	3	
2	3		3		3	1	2			3		3	3	
3	3		3		3	1	2	2		3		3	3	
4	3		3		3	1	2			3		3	3	
5	3		3		3	1	2	2		3		3	3	

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

OPEN ELECTIVES OFFERED IN EVEN SEMESTER

OE22062	INDUSTRIAL AUTOMATION	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Recapitulate the working of sensors and signal conditioning process
- Study of components and circuits associated with pneumatics and hydraulics
- Learn the operation and programming of PLCs and human machine interfaces.
- Obtain an overview of distributed control systems and CNC machines
- Familiarize with the interconnection and data exchange between PLCs, field devices and supervisory units with different bus structures.

UNIT I	SENSOR AND MEASUREMENT SYSTEMS	9

Introduction to Industrial Automation – Architecture - Sensors and measurement systems for position, temperature, pressure, displacement, flow and level - Signal conditioning &Processing - Smart sensors – Basics of Industry 4.0 - Concept of Industry 5.0 -IoT for plant automation.

UNIT II	PNEUMATICS AND HYDRAULICS	9

Pneumatics: Types of Pneumatic actuators, selection of actuators, control valves for direction, pressure and flow. Compressor – types. Hydraulics: Pumps and motors, servo and proportional valves. Circuit design - symbols, schematic, travel step diagram, Classical method.

UNIT III	PLCs	9

Introduction - Advantages, capabilities & Internal architecture. Scan cycle, Types of I/O modules, Analog Scaling, PLC Wiring, Selection criteria for PLC. Types of Programming. Program development – Flow charts & Pseudocode, Bit instructions, Arithmetic functions, timers, counters, data transfer.VFD, Motor Speed Control using VFD and PLC Programming.

UNIT IV	HMI, DCS and CNC	9

Introduction to HMI and SCADA- DCS: Architecture, local control unit, programming language, communication facilities, operator interface, engineering interfaces. CNC: Features, drive systems for CNC machine tools, Control of machine tools. Introduction to Industrial AR

UNIT V	NETWORKING AND ROBOTICS	9

Networking of sensors, actuators and controllers – Industrial Communication Protocols: Fieldbus, Profibus, Profinet, Modbus, Ethernet IP, IEEE Standards - Introduction to Robotics, Work volume, End Effectors, Robotic sensors and Machine vision.

TOTAL PERIODS: 45

TEXT BOOKS

1.	S. Mukhopadhyay, S. Sen and A. K. Deb, 'Industrial Instrumentation, Control and Automation', Jaico Publishing House, 2013.
2.	Frank D Petruzella, 'Programmable Logic Controllers', McGraw Hill Inc, 2005

REFERENCE BOOKS

1.	W. Bolton, 'Mechatronics', Pearson Education, 2009
2.	Kelvin T Erikson, 'Programmable Logic Controllers ', Dogwood Valley Press, 2005
3.	L.A.Bryan, E.A.Bryan, 'Programmable controllers – Theory and Implementation', Industrial Text company, 1997, 2nd Edition.
4.	Steve Mackay, 'Practical Industrial data networks: Design, Installation and Troubleshooting',

	Elsevier Newnes, 2004.
5.	B.G.Liptak, 'Instrument Engineers handbook', CRC press, 3rd Edition.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Choose and design a suitable measurement system and understand the basic concept of IoT	3
2	Configure a pneumatic / hydraulic circuit as per requirements	3
3	Design and program a PLC system for an application	3
4	Controls a PLC through human-machines interfaces and understand basic concepts of DCS & CNC machines.	3
5	Network PLCs with field devices and understand basic concepts of Robotics	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3	1	1				1		2		
2	3	3	3	3	3	1				1		2		
3	3	3	3	3	3	1				1		2		
4	3	3	3	3	3	1				1		2		
5	3	2	3	2	2	1				1		2		

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

OE22064	DIGITAL SYSTEMS	LTP C
		3 0 0 3

COURSEOBJECTIVES

- Toimpartknowledgeonconceptsofbinaryrepresentation, logic gates andBooleanalgebra.
- To design andanalyzedigitalcircuitsusingcombinational logic.
- Todesign andanalyze digitalcircuitsusing sequential logic.
- To understand the logic of memory devices.

UNITI	NUMBERSYSTEMS,CODESANDBOOLEAN ALGRBRA	11

Review of number systems, signed binary numbers – Binary Arithmetic – Boolean Algebra - laws and theorems – Simplification of Boolean expressions – Sum of Products (SOP) and Product of Sums (POS) forms – Logic Minimization using K-map – Binary codes – BCD code, Gray code, Error detection and Error correction codes.

UNITII	COMBINATIONALCIRCUITS	9

Combinationallogic–Adders,Subtractor,Multiplexer, Demultiplexer, Encoder, Decoder, Parity generator and checker – code converters

UNITIII	SEQUENTIALCIRCUITS	11

Sequential logic – SR, JK, D and T flip flops –Synchronous counter – synchronous sequential circuits -Design of synchronous sequential circuits Counters: Synchronous and Asynchronous - State diagram-state reduction – state assignment.

UNITIV	ASYNCHRONOUSSEQUENTIALCIRCUITS	7

Analysis of asynchronous sequential logic circuits – State reduction – state assignment Asynchronous design problem.

UNITV	MEMORYDEVICESANDDIGITALLOGICALFAMILIES	7

Implementation of combinational logic circuits using PROM, PLA, PAL – Introduction to FPGA – Digital Logic Families: Logic gates using TTL, ECL and MOS families – operation and characteristics of digital logical family.

TOTALPERIODS:45

TEXT BOOKS

1.	Salivahanan, Arivazhagan, 'Digital Circuits & Design', Vikas Publishing House, 2012.
2.	Floyd and Jain, 'Digital Fundamentals', Pearson Education, 2013, 8th Edition.

REFERENCE BOOKS

1.	Anand Kumar, 'Fundamentals of Digital Circuits', PHI,2013.
2.	Mandal, 'Digital Electronics Principles & Application', McGraw Hill Education, 2014.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Apply the concepts of Boolean algebra and reduction techniques to minimize logic expressions	3
2	Analyze and design various combinational logic circuits.	4
3	Investigate and design synchronous sequential circuits	4
4	Investigate and design asynchronous sequential circuits	4
5	Comprehend the operation characteristics of memory devices, digital logic families and construct digital circuits with memory devices	3

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3							2	2				
2	3	3	2	2					2	2		2		
3	3	3	2	2		2			2	2		2		
4	3	3	2	2		2			2	2		2		
5	3	3	2	2		2			2	2		2		

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

OE22606	MOTORS FOR INDUSTRIES	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand steady state operation and dynamics of a motor load system.
- To study and analyze the operation of the converter / chopper fed dc drive, both qualitatively and quantitatively.
- To study and understand the operation and performance of AC Induction motor drives.
- To study and understand the operation and performance of AC Synchronous motor drives.
- To obtain the knowledge on motor to the specific industrial and EV application.

UNIT I	INTRODUCTION TO ELECTRICAL DRIVES AND ITS DYNAMICS	9

Electrical drives– choice of electrical drives–status of dc and ac drives–Equation governing motor load dynamics – Fundamental torque equation– multi quadrant operation– Equivalent values of drive parameters–components of load torque– nature and classification of load torques– steady state stability- Thermal model of motor for heating and cooling–Classes of motor duty–Selection of motor power rating.

UNIT II	DC MOTOR DRIVES	9

Steady state analysis of the single and three phase converter fed separately excited DC motor drive – continuous and discontinuous conduction – Time ratio and current limit control – Four quadrant operation of converter / chopper fed drive– converter / chopper control of DC series motor

UNIT III	INDUCTION MOTOR DRIVES	9

Induction motor–Construction, Principle of operation–Stator voltage control–V/f control – field weakening mode – VSI / CSI fed drive – Slip power recovery drive–speed control of single-phase induction motors.

UNIT IV	SYNCHRONOUS MOTOR DRIVES	9

Operation from fixed frequency supply, synchronous motor variable speed drives, variable frequency control of multiple synchronous motors– Self-controlled synchronous motor drive employing load commutated thyristor inverter–Margin angle control – Power factor control

UNIT V	DRIVES FOR INDUSTRIAL AND EV APPLICATIONS	9

Introduction – Speed and Torque control of above and below rated speed–Steel mills–Paper mill-cement mill–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.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Gobal K. Dubey, 'Fundamentals of Electrical Drives', Narosa Publishing House, New Delhi, 2001, 2nd Edition.
2.	R.Krishnan, 'Electric Motor Drives – Modeling, Analysis and Control', Prentice-Hall of India Pvt. Ltd., New Delhi, 2010.

REFERENCE BOOKS

1.	Vedam Subramanyam, 'Electric Drives – Concepts and Applications', Tata McGraw-Hillpublishing company Ltd., New Delhi, 2002.
2.	Ali Emadi, 'Handbook of Automotive Power Electronics and Motor Drives', Taylor and Francis, 2005, 1st Edition.
3.	Bimal K Bose, 'Modern Power Electronics and AC Drives', Pearson Education Asia, 2002.
4.	Bimbhra B.S., 'Power Electronics', Kanna Publishers, New Delhi, 2012, 5th Edition.

5.	S.K.Pillai, 'A First course on Electrical Drives, New Age International publishers', 2012, 3rd Edition.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Select the motor and its rating for a known load characteristic.	3
2	Analyze and design a converter for a dc drive.	4
3	Understand the operation and control of induction motor drives	3
4	Understand the operation and control of synchronous motor drives	3
5	Choose and design a drive for a given application.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3		1	2		2	2		2		
2	3	3	3	3		1	2		2	2		2		
3	3	3	3	3		1	2		2	2		2		
4	3	3	3	3		1	2		2	2		2		
5	3	3	3	3		1	2		2	2		2		

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

OE22608	INDIAN POWER GRID	LTP C
		30 0 3

COURSE OBJECTIVES

- Comprehend Indian grid codes
- Study the concepts of restructuring of power system.
- To learn the various types of renewable sources of energy with storage technologies.
- Explore the types, planning and operational issues related to Microgrids.
- Investigate the various smart grid initiatives, metering and communication technologies.

UNITI	INTRODUCTION TO GRID CODES	9

Basics structure of power systems, Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, Functions, opportunities, challenges and benefits, Difference between conventional and smart Grid, Role of various Organizations and their linkages, Planning Code for Inter State Transmission, Connection Code, Operating Code for Regional Grids, Scheduling and Despatch Code.

UNITII	ELECTRICITY DEREGULATION	9

Motivation for Restructuring of Power System - Electricity Market Entities and Models - Milestones and Benefits of deregulation - Availability based tariff - Day Scheduling process - Definition and Technologies of Distributed Generation - Indian power sector past and present status - Growth of power sector in India - Players in the Indian power sector.

UNITIII	RENEWABLE ENERGY	9

Introduction to non-conventional energy resources - Overview of solar energy technologies - Solar Photovoltaic devices - Performance and durability of solar devices - Wind energy - technology and geographical aspects - Geothermal and Biomass - Energy storage - Batteries - Fuel cell - Characterization and durability, Concept of wind and solar hybrid system.

UNITIV	MICRO GRID	9

Microgrids vs Central Conventional power system - Structure of Microgrid - Types of Microgrid system - Operations of AC and DC Microgrids - Comparison - Power Electronic Converters in Microgrid application - DC Microgrid: Topologies - Application – Standards, Challenges in AC and DC micro grid.

UNITV	SMART GRID	9

National and International Initiatives in Smart Grid-Implementation of smart grid technologies in India, Architecture - Standards and policies - Control layer and elements - Power line communications- Advanced metering infrastructure - Phasor measurement units - Wide Area Measurement Systems (WAMS)- Introduction to Internet of things (IoT).

TOTAL PERIODS:45

TEXT BOOKS

1	Kankar Bhattacharya Maath H.J. Bollen and Jaap E.Daalder, 'Operation of restructured power systems', Kluwer academic publishers, USA, 2001, 1st Edition.
2	Janaka Ekanayake and Kithsiri Liyanage and Jianzhong Wu and Akihiko Yokoyama, 'Smart Grid: Technology and Applications', John Wiley, 2015.

REFERENCE BOOKS

1	Daniel Kirschen and Goran Strbac,'Fundamentals of power system economics', John Wiley sons,September 2018, 2nd Edition.
2	P.Venkatesh, B.V.Manikandan, S.Charles Raja and A.Srinivasan, 'Electrical power systems analysis', Security and Deregulation, PHI 2012.
3	Indu Shekhar Jha. D.P.Kothari, 'Smart Grid Fundamentals and Applications', New Age

	International publishers, January 2019, 1st Edition.
4	Bahman Zohuri, 'Hybrid Energy Systems', Springer, 2018, 1st Edition.

COURSE OUTCOMES

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

COs	STATEMENTS	RBT LEVEL
1	Interpret the Indian power grid codes	3
2	Investigate the deregulated electricity market models functioning	4
3	Examine the renewable energy based electrical power generation in India	4
4	Analyze microgrid planning and operational issues with Distributed Generators	4
5	Explore the smart grid concepts, meteing and communication networks	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3				3				3		
2	3	3	3	3				3				3		
3	3	3	3	3								3		
4	3	3	3	3				2				3		
5	3	3	3	3				3				3		

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

OE22610	INDUSTRIAL IOT	L T P C
		3 0 0 3

COURSE OBJECTIVES

- To understand the fundamentals of Industrial Internet of Things
- To learn about the basics of IoT protocols
- To explore and implement data access, analysis and control.
- To build a small low cost embedded system using IoT
- To apply the concept of IoT in the real world scenario.

UNIT I	INTRODUCTION TO INDUSTRIAL IoT SYSTEMS	9

Definition – market size - Role of Internet of Things and Industrial Internet of Things - IIoT Value Chain - Industrial Revolutions - Industry 4.0 -Support System for Industry 4.0 - Smart Factories – Architecture of Industrial IoT.

UNIT II	IMPLEMENTATION SYSTEMS FOR IIoT	9

Sensors and actuators for industrial processes - Sensor networks - Process automation and data acquisitions on IoT platform - Microcontrollers and Embedded PC roles in IIoT - Wireless Sensor nodes with Bluetooth, Wifi and LoRa Protocols - IoT Hub systems.

UNIT III	IIOT DATA MONITORING AND CONTROL	9

IoT Gate way - IoT Edge Systems - Programming - Cloud computing - Real Time Dashboard for Data Monitoring - Data Analytics and Predictive Maintenance with IIoT technology - Economics of IIoT - Smart Factories.

UNIT IV	CYBER PHYSICAL SYSTEMS	9

Next Generation Sensors - Collaborative Platform and Product Lifecycle Management - Augmented Reality and Virtual Reality – Role of Artificial Intelligence and machine learning - Big Data and Advanced Analysis – Security.

UNIT V	CASE STUDY	9

Industrial IOTApplication Domains: Oil, chemical and pharmaceutical industry, Inventory management and Quality control, Real case studies: Milk Processing and Packaging Industries, Manufacturing Industries-Future of IIoT.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Alasdair Gilchrist, 'Industry 4.0: The Industrial Internet of Things', 2017, Apress Publication, 1st Editon.
2.	Sudip Misra, Chandana Roy, Anandarup Mukherjee, 'Introduction to Industrial Internet of Things and Industry 4.0', CRC Press,2020, 1st Editon.

REFERENCE BOOKS

1.	Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, 'Industrial Internet of Things: Cyber manufacturing Systems',(Springer), 2017.
2.	Yasser Ismail, 'Internet of Things (IoT) for Automated and Smart Applications', IntechOpen, 2019, 1st Editon.
3.	Ismail Butun , "Industrial IoT: Challenges, Design Principles, Applications, and Security", Springer International Publishing AG, 2020, 1st Edition.
4.	Ioana Culic, Alexandru Radovici, Cristian Rusu, 'Commercial and Industrial Internet of Things

	Applications with the Raspberry Pi: Prototyping IoT Solutions', Springer India, 2022, 1st Edition.
5.	Giacomo Veneri, Antonio Capasso, 'Hands-On Industrial Internet of Things: Create a powerful Industrial IoT Infrastructure using Industry 4.0', Packt Publishing, 2018,1st Edition.

COURSE OUTCOMES

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

COs	**STATEMENTS**	**RBT LEVEL**
1	Analyse the growth of industrial revolution and understand the basic concepts and architectures of Internet of Things.	4
2	Analyze various implementation systems for IIoT.	4
3	Realize the importance of Data Monitoring and control in IIoT.	4
4	Investigate various IIoT cyber physical systems.	4
5	Explore the applications of IIoT and case studies.	4

Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2					1		2		3	3	
2	3	3	2	3				1		2		3	3	
3	3	3	2					1		2		3	3	
4	3	3	2	3				1		2		3	3	
5	3	3	2	3				1		2		3	3	

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

OE22612	ELECTRICAL AUTOMATION AND ROBOTICS	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Recapitulate the working of sensors and signal conditioning process.
- Learn the operation and programming of PLCs
- Study of components and circuits associated with pneumatics control circuits
- To impart a knowledge on robotics and associated components
- To get familiarized on robot kinematics and programming

UNIT I	SENSOR AND MEASUREMENT SYSTEMS	9

Introduction to Industrial Automation – Architecture - Sensors and measurement systems for position, temperature, pressure, displacement, flow and level - Signal conditioning & Processing - Smart sensors – Sensor for Robot: Range, Touch, Tactile, Force and slip sensors.

UNIT II	PLCs	9

Introduction – Advantages & Internal architecture. Scan cycle, Types of I/O modules, Analog Scaling, Selection criteria for PLC, Types of Programming, Ladder logic programming: Contacts, Coils, Bit instructions, Arithmetic functions, timers, counters and data transfer instructions.

UNIT III	PNEUMATICS AND ELECTRO- PNEUMATICS	9

Pneumatics: Types of Pneumatic actuators, selection of actuators, control valves for direction, pressure and flow. Compressor – types, Electro-Pneumatics: Components, Solenoid valve, Electrical timer and counters, Proximity Sensors, Circuit design for industrial application.

UNIT IV	FUNDAMENTALS OF ROBOTICS	9

Definition- Laws of Robot- Robot Anatomy- Degree of Freedom- Types of Joints- Four Robot Configuration, Work Envelop -Types of Robots– Specifications – Industrial Application- Robot Drive System: Stepper, Servo and DC motor, End Effectors.

UNIT V	KINEMATICS AND PROGRAMMING	9

Forward and inverse kinematics, Forward and Reverse kinematic of manipulator with 2-DOF and 3-DOF, Robot Programming Languages- Simple programs for industrial automation.

TOTAL HOURS: 45

TEXT BOOKS

1.	S. Mukhopadhyay, S. Sen and A. K. Deb, 'Industrial Instrumentation, Control and Automation', Jaico Publishing House, 2013.
2.	Mikell P.Groover, Mitchell Weiss, Roger N. Nagel and, Nicholas G.Odrey, and Ashish Dutta, 'Industrial Robotics -Technology',Programming and Applications, 2013, 2nd Edition.

REFERENCE BOOKS

1.	William C.Dunn, 'Fundamentals of Industrial Instrumentation and Process control', McGraw Hill, 2005.
2.	Frank D Petruzella'Programmable Logic Controllers', McGraw Hill Inc, 2005.
3.	Peter Corke, 'Robotics,Vision and control-Fundamental algorithms in MATLAB', Springer International publishing, 2017.
4.	Mittal RK, Nagrath IJ, 'Robotics and control', Tata McGraw Hill, 2010.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Choose and design a suitable sensor and measurement system	4
2	Design and develop program a PLC system for an application	4
3	Design and develop a program to electro-pneumatic circuit for a industrial application	4
4	Acquire knowledge about robotics anatomy, DOF and drives	3
5	Develop a program to use robot for a typical application	5
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3				2	2	2	1		3		
2	3	3	3		3		2	2	2	1		1		
3	3	3	3		3		2	2	2	1		2		
4	3	3	3					3	2	1		3		
5	3	3	3		3			3	1	1		1		

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping

OE22614	INDUSTRIAL NANOTECHNOLOGY	L T P C
		3 0 0 3

COURSE OBJECTIVES

- Students will get trained in semiconductor Nanotechnology and microfabrication
- Students will be demonstrated with various synthesis methods of nanostructures
- Students will be able to characterize any form of nanostructures
- Students will be provided with hands-on training on nanostructure synthesis
- Students will be provided with hands-on training on characterization of nanostructures

UNIT I	INTRODUCTION TO NANOTECHNOLOGY	9

Introduction to semiconductor processing – Necessity for a clean room– different types of clean rooms– Structure and requirements of a clean room– Safety issues, flammable and toxic hazards, biohazards – Microfabrication process flow diagram – Chip cleaning, coating of photoresists, patterning, etching, inspection – Process integration – Etching techniques– Wet and Dry Etching– Reactive Ion etching.

UNIT II	GENERAL METHODS OF PREPARATION	9

Preparation of nanoscale materials: Spray Pyrolysis, Co–Precipitation, Sol–gel, Mechanical Milling, Self–assembly, Preparation of thin films: Electroplating, Sputtering, Evaporation, MOCVD, Molecular Beam Epitaxy, Atomic Layer Epitaxy and Pulsed layer deposition.

UNIT III	CHARACTERIZATION TECHNIQUES	9

X–ray diffraction technique, Scanning Electron Microscopy – environmental techniques, Transmission Electron Microscopy including high–resolution imaging, Surface Analysis Techniques – AFM, SPM, STM, SNOM, ESCA, DLS.

UNIT IV	NANODEVICE FABRICATION	9

Vacuum pumps and Vacuum deposition – Thin film deposition – Photolithography, patterning and Etching - Electrical characterization. Fabrication of Nano scale device and prototyping.

UNIT V	INDUSTRIAL APPLICATIONS OF NANOTECHNOLOGY	9

Industrial coatings – Organic and inorganic coatings – Nano medicines, Targetted drug delivery - Nano crystalline silver for bacterial inhibition, Nanoparticles for sun barrier products - Nanoelectronics - Quantum information – Quantum computing – Nanotechnology in Artificial Intelligence.

TOTAL PERIODS: 45

TEXT BOOKS

1.	Madou Marc J, 'Fundamentals of Microfabrication and Nanotechnology', CRC Press, New York, 2011, 3rd Edition.
2.	Fahrner W.R., 'Nanotechnology and Nanoelectronics', Springer (India) Private Ltd., 2011.

REFERENCE BOOKS

1.	B.G. Streetman and S. Banerjee, 'Solid State Electronic Devices', PHI Learning, 2009, 6th Edition.
2.	CMOS: Circuit Design, Layout, and Simulation by R. Jacob Baker, Wiley-IEEE Press, 2019.

COURSE OUTCOMES Upon the successful completion of the course, the students will be able to		
COs	**STATEMENTS**	**RBT LEVEL**
1	Understand cutting-edge semiconductor process technology in a cleanroom	4
2	Synthesis nanostructures using variety of semiconductor technology for a given application.	4
3	Characterize any specific nanostructure structurally, electrically and by imaging.	4
4	Design any nanodevice as a prototype, using vacuum pumps, physical deposition, photolithography and etching.	4
5	Apply the concepts of nano-fabrication processes in various industrial nanotechnology applications in sub-micron and nano-scale level.	3
Bloom's Taxonomy (RBT) Level: Remember-1; Understand-2; Apply-3; Analyze-4; Evaluate-5; Create-6		

COURSE ARTICULATION MATRIX

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3						2	2				3
2	3	3	3	3	3			3	2	2				3
3	3	3	3	3	3			3	2	2				3
4	3	3	3	3	3			3	2	2				3
5	3	3	3	3	3		3	3	2	2		3		3

3- High Mapping; 2-Moderate Mapping; 1-Low Mapping