DHANALAKSHMI SRINIVASAN ENGINEERING COLLEGE

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

PERAMBALUR-621212

REGULATIONS–2023

CHOICE BASED CREDIT SYSTEM

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CURRICULUM & SYLLABI

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

(Applicable to students admitted from the Academic year 2023 – 2024 and subsequently under Choice Based Credit System)

Discussed in BOS-4 meeting Dated: 18.09.2024 / EEE Ratified & Approved in Academic Council

VISION MISSION OF THE INSTITUTION

Vision:

An active and committed centre of advanced learning focused on research and training in the fields of Engineering, Technology and Management to serve the nation better.

Mission:

- To develop eminent scholar with a lifelong follow up of global standards by offering UG,PG and Doctoral Programmes.
- To pursue Professional and Career growth by collaborating mutually beneficial partnership with industries and higher institutes of research.
- To promote sustained research and training with emphasis on human values and leadership qualities.
- To contribute solutions for the need based issues of our society by proper ways and means as dutiful citizen.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

About the Department

The Department of Electrical and Electronics Engineering, DhanalakshmiSrinivasan Engineering College, Perambalur was established in the year 2001 - 2002 and affiliated to ANNA UNIVERSITY, Chennai. Two Post-Graduate programmes M.E. in Power Electronics and Drives during the academic year 2011-2012 and Embedded System Technologies during the academic year 2012-2013 have been introduced. We have a leading edge teaching facility and state-of-the-art laboratory facilities to enhance the learning experience of the students. The department develops the analytical and practical skills of students to serve better industrial, organizational and research set ups.

We provide individual attention and world class quality of education. We have a team of highly qualified, experienced and dedicated faculty to impart quality education to the students. The Department has been accredited by NBA (National Board of Accreditation). The EEE Department has been organizing many Symposiums, Seminars, Conference, Workshop, Guest lectures and the IEEE Chapter.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Vision:

To infuse technical competencies of Electrical and Electronics Engineering and provide research ambience with values.

Mission:

- To impart quality education and training in Electrical and Electronics Engineering with an overall background suitable for making a successful Engineer in industry and research or higher education.

- To develop life-long learning skills that allows them to be adaptive and responsive tochanges in society, technology and the environment, as well as career demands.

- To provide an accredited dynamic scholarly environment wherein students learn todevelop communications and leadership abilities to blossom as a professional.

- To ensure that every graduate is aware of the roles and responsibilities of the professional engineer in society through exposure to ethics, equity, safety and health considerations.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1	Graduates will possess expertise in problem analysis, solving, designing, skills and necessary information for a successful career in the field of Electrical and Electronics Engineering.
PEO 2	Graduates will accomplish practical acquaintance in modern designing tools,technologies and Engineering software in Electrical and ElectronicsEngineering.
PEO 3	Graduates will be outstanding in communication, teamwork and multidisciplinaryapproach related to engineering issues in social context.
PEO 4	Graduates will excel in competitive environment towards leadership and life-longlearning which is needed for a successful professional career.

PROGRAM OUTCOMES(POs)

PO	GraduateAttribute
PO1	**Engineering knowledge -** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis -** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/Development of solutions -** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems -** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5	**Modern tool usage -** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The Engineer and Society -** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and Sustainability -** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics -** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work -** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10	**Communication -** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance -** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning -** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMSPECIFICOUTCOMES(PSOs)

PSO 1	**Power Networks** - Assess feasibility, applicability and optimality in power networks.
PSO 2	**System Simulation** - Ability to use software for design, simulation and analysis of electrical systems.

PEO's – PO's & PSO's MAPPING:

PEO	**PO**												**PSO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
I.	3	1	2	2	-	1.5	--	-	-	-	-	1	2	1
II.	-	3	3	2	3	1	-	-	1.5	1	1	1	3	3
III.	-	-	-	-	-	3	3	2.8	3	3	2	1	-	-
IV.	-	-	-	-	-	3	2	2	3	-	2	3	-	-

DHANALAKSHMI SRINIVASAN ENGINEERING COLLEGE (AUTONOMOUS), PERAMBALUR – 621 212

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

REGULATIONS – 2023

CHOICE BASED CREDIT SYSTEM

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	IP3151	Induction Programme		-	-	-		0
2	U23HST11	Communicative English	HS	3	0	0	3	3
3	U23MAT12	Matrices and Calculus	BS	3	1	0	4	4
4	U23PHT13	Physics for Engineers and Technologists	BS	3	0	0	3	3
5	U23CYT14	Chemistry for Engineering & Technology	BS	3	0	0	3	3
6	U23GET16	Engineering Graphics	ES	4	0	0	4	4
7	GE3152	Heritage of Tamil	HS	1	0	0	1	1
PRACTICAL								
8	U23BSP11	Physics and Chemistry Laboratory	BS	0	0	3	3	2
9	U23HSP12	English Laboratory	EEC	0	0	2	2	1
10	U23GEP14	Engineering Practices Laboratory	ES	0	0	4	2	2
			TOTAL	**17**	**1**	**9**	**25**	**23**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23HST21	Professional English	HS	3	0	0	2	2
2	U23MAT22	Statistics and Numerical Methods	BS	3	1	0	4	4
3	U23GET15	Problem solving and Python Programming	ES	3	0	0	3	3
4	U23PHT24	Physics for Electrical and Electronics Engineers	ES	3	0	0	3	3
5	U23MET25	Basic Civil and mechanical Engineering	ES	3	0	0	3	3
6	U23EET21	Electric Circuit Analysis	PC	3	0	0	3	3
7		NCC Credit Course Level 1	-	-	-	-	-	2*
8	GE3252	தமிழரும் தொழில்நுட்பமும்/Tamils and Technology	HS	1	0	0	1	1
PRACTICAL								
9	U23EEP21	Electric Circuits Laboratory	ES	0	0	4	4	2
10	U23HSP22	Communication Laboratory	EEC	0	0	2	2	2
11	U23GEP13	Problem solving and Python Programming Laboratory	ES	0	0	4	4	2
			TOTAL	**19**	**1**	**10**	**29**	**25**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23MAT31	Transforms and Partial Differential Equations	BS	3	1	0	4	4
2	U23EET31	Measurement and Instrumentation Systems	ES	3	0	0	3	3
3	U23EET32	Digital LogicCircuits	PC	3	0	0	3	3
4	U23EET33	Electric and Magnetic Fields	PC	3	0	0	3	3
5	U23EET34	Electronic Devices and Circuits	PC	3	0	0	3	3
6	U23EET35	DC Machines and Transformers	PCC	3	0	0	3	3
PRACTICAL								
8	U23EEP31	Electronic Devices and CircuitsLaboratory	PCC	0	0	3	3	1.5
9	U23EEP32	DC Machines and transformers Laboratory	PCC	0	0	3	3	1.5
			TOTAL	**18**	**1**	**6**	**25**	**22**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23EET41	Induction and Synchronous Machines	PCC	3	0	0	3	3
2	U23GET41	Environmental Sciences and Engineering	BSC	2	0	0	3	2
3	U23EET42	Transmission and Distribution	PCC	3	0	0	3	3
4	U23CST35	C Programming and Data Structures	PCC	3	0	0	3	3
5	U23EET43	Linear Integrated Circuits and Applications	PCC	3	0	0	3	3
6	U23EET44	Analog and Digital Communication	PCC	3	0	0	3	3
PRACTICAL								
7	UT23EEP41	Induction and Synchronous Machines Laboratory	PCC	0	0	3	3	2
8	UT23EEP42	Linear and Digital Circuits Laboratory	PCC	0	0	3	3	1.5
9	U23CSP33	C Programming and Data Structures Laboratory	PCC	0	0	3	3	1.5
			TOTAL	**17**	**0**	**9**	**27**	**22**

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23EET51	Control Systems	PCC	3	1	0	3	4
2	U23EET52	Microprocessors and Microcontrollers	PCC	3	0	0	3	3
3	U23EET53	Protection and Switchgear	PCC	3	0	0	3	3
4	U23EET54	Principles of Digital Signal Processing	PCC	3	0	0	3	3
5		Professional Elective – 1	PEC	3	0	0	3	3
6		Open Elective – 1	OEC	3	0	0	3	3
PRACTICAL								
7	U23EEP51	Measurement and Control System Laboratory	PCC	0	0	3	3	1.5
8	U23EEP52	Microprocessors and Microcontrollers Laboratory	PCC	0	0	3	3	1.5
			TOTAL	**18**	**1**	**6**	**24**	**22**

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23EET61	Power Electronics	PCC	3	0	0	3	3
2	U23EET62	Embedded Systems	PCC	3	0	0	3	3
3	U23EET63	Power System Analysis	PCC	3	1	0	4	4
4	U23EET64	High Voltage Engineering	PCC	3	0	0	3	3
5		Professional Elective – 2	PEC	3	0	0	3	3
6		Professional Elective – 3	PEC	3	0	0	3	3
PRACTICAL								
7	UT23EEP61	Power Electronics and Drives Laboratory	PCC	0	0	3	3	1.5
8	U23HSP61	Professional Communication	EEC	0	0	2	2	1
9	UT23EEP62	Mini-project	EEC	0	0	3	3	1.5
			TOTAL	**18**	**1**	**8**	**27**	**23**

SEMESTER VII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23EET71	Power System Operation and Control	PCC	3	0	0	3	3
2	U23GET61	Human Values and Ethics	HSMC	3	0	0	3	2
3		Professional Elective – 4	PEC	3	0	0	3	3
4		Professional Elective – 5	PEC	3	0	0	3	3
5		Open Elective – 2	OEC	3	0	0	3	3
PRACTICAL								
6	U23EEP71	Power System Simulation laboratory	PCC	0	0	3	3	1.5
7	U23EEP72	Electrical Design and Green Energy laboratory	PCC	0	0	3	3	1.5
			TOTAL	**15**	**0**	**6**	**21**	**17**

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Professional Elective – 6	PCC	3	0	0	3	3
2		Professional Elective – 7	PEC	3	0	0	3	3
PRACTICAL								
3	U23EEP81	ProjectWork	EEC	0	0	12	12	10
			TOTAL	**6**	**0**	**12**	**18**	**16**

VERTICALS I ENERGY AND POWER SYSTEMS

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23EEV11	Power Quality and Flexible AC Transmission Systems	PEC	3	0	0	3	3
2	U23EEV12	Restructured Power Systems	PEC	3	0	0	3	3
3	U23EEV13	Energy Management and Auditing	PEC	3	0	0	3	3
4	U23EEV14	Electrical Energy Utilization and Conservation	PEC	3	0	0	3	3
5	U23EEV15	Power Plant Instrumentation and Control	PEC	3	0	0	3	3
6	U23EEV16	Microgrids	PEC	3	0	0	3	3
			TOTAL	**18**	**0**	**0**	**18**	**18**

VERTICALS II EMBEDDED AND AUTOMATION CONTROL

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23EEV21	Embedded System Design	PEC	3	0	0	3	3
2	U23EEV22	Smart System Automation	PEC	3	0	0	3	3
3	U23EEV23	MEMS and NEMS	PEC	3	0	0	3	3
4	U23ECO13	VLSI Design	PEC	3	0	0	3	3
5	U23EEV25	Embedded Control for Electric Drives	PEC	3	0	0	3	3
6	U23EEV26	SCADA and Distributed Control Systems	PEC	3	0	0	3	3
			TOTAL	**18**	**0**	**0**	**18**	**18**

VERTICALS III ELECTRIC VEHICLE TECHNOLOGY

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23EEV31	Electric Vehicle Architecture	PEC	3	0	0	3	3
2	U23EEV32	Design of Motor and Power Converters for Electric Vehicles	PEC	3	0	0	3	3
3	U23EEV33	Intelligent Control of Electric Vehicles	PEC	3	0	0	3	3
4	U23EEV34	Grid Integration of Electric Vehicles	PEC	3	0	0	3	3
5	U23EEV35	Design of Electric Vehicle Charging System	PEC	3	0	0	3	3
6	U23EEV36	Electric Vehicle Design, Mechanics and Control	PEC	3	0	0	3	3
			TOTAL	**18**	**0**	**0**	**18**	**18**

VERTICALS IV GENERAL

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23AIT41	Artificial Intelligence for Engineers	PEC	3	0	0	3	3
2	U23EEV42	Data Science for Engineers	PEC	3	0	0	3	2
3	U23ECT43	Digital Signal Processing	PEC	3	0	0	3	3
4	U23EEV44	Fundamentals of Robotics	PEC	3	0	0	3	3
5	U23BMT41	BiomedicalInstrumentation	PEC	3	0	0	3	3
6	U23EEV46	Advanced Microprocessor and Microcontrollers	PEC	3	0	0	3	3
			TOTAL	**18**	**0**	**0**	**18**	**18**

VERTICALS V CONVERTERS AND DRIVES

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23EEV51	Multilevel Power Converters	PEC	3	0	0	3	3
2	U23EEV52	Power Electronics for Renewable Energy Systems	PEC	3	0	0	3	3
3	U23EEV53	Control of Power Electronics Circuits	PEC	3	0	0	3	3
4	U23EEV54	SMPS and UPS	PEC	3	0	0	3	3
5	U23EEV55	Electrical Drives and Control	PEC	3	0	0	3	3
6	U23EEV56	Analysis of Electrical Machines	PEC	3	0	0	3	3
			TOTAL	**18**	**0**	**0**	**18**	**18**

VERTICALS VI INTERNET OF THINGS

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23EEV61	Sensors and Actuators	PEC	3	0	0	3	3
2	U23EEV62	IoT Architecture and Framework	PEC	3	0	0	3	2
3	U23EEV63	Communication Protocols for IoT	PEC	3	0	0	3	3
4	U23EEV64	Cloud Services for IoT	PEC	3	0	0	3	3
5	U23EEV65	Big Data Analytics for IoT	PEC	3	0	0	3	3
6	U23EEV66	Architecting Smart IoT Devices	PEC	3	0	0	3	3
			TOTAL	**18**	**0**	**0**	**18**	**18**

VERTICALS VII ADVANCED CONTROL

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23EEV71	Model BasedControl	PEC	3	0	0	3	3
2	U23EEV72	Non Linear Control	PEC	3	0	0	3	2
3	U23EEV73	Optimal Control	PEC	3	0	0	3	3
4	U23EEV74	Adaptive Control	PEC	3	0	0	3	3
5	U23EEV75	Computer Control of Processes	PEC	3	0	0	3	3
6	U23EEV76	Machine Monitoring System	PEC	3	0	0	3	3
			TOTAL	**18**	**0**	**0**	**18**	**18**

VERTICALS VIII DIVERSIFIED COURSES

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23EEV81	Hybrid Energy Technology	PEC	3	0	0	3	3
2	U23EEV82	Energy Storage Systems	PEC	3	0	0	3	2
3	U23EEV83	Sustainable and Environmental Friendly HV Insulation System	PEC	3	0	0	3	3
4	U23EEV84	Grid Integrating Techniques and Challenges	PEC	3	0	0	3	3
5	U23EEV85	Design and Modelling of Renewable Energy Systems	PEC	3	0	0	3	3
6	U23EEV86	PLC Programming	PEC	3	0	0	3	3
			TOTAL	**18**	**0**	**0**	**18**	**18**

OPEN ELECTIVE I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23MEV36	Renewable Energy Technologies	OEC	3	0	0	3	3
2	U23EEO12	Electric and HybridVehicles	OEC	3	0	0	3	3
3	U23EEO13	Energy Conservation and Management	OEC	3	0	0	3	3
4	U23ECO12	Fundamentals of Electronic Devices and Circuits	OEC	3	0	0	3	3
5	U23EEO15	Batteries and Management System	OEC	3	0	0	3	3
			TOTAL	**15**	**0**	**0**	**15**	**15**

OPEN ELECTIVE II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23EEO21	Automotive Electrical and Electronics	OEC	3	0	0	3	3
2	U23EEO22	Electrical, Electronic and Magnetic Materials	OEC	3	0	0	3	3
3	U23EEO23	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3
4	U23RAV28	Industrial Safety	OEC	3	0	0	3	3
5	U23EEO25	Electric Power Generation	OEC	3	0	0	3	3
			TOTAL	**15**	**0**	**0**	**15**	**15**

SUMMARY

Sl.No.	SubjectArea	Credits per semester								Credits Total	Percentage %
		I	II	III	IV	V	VI	VII	VIII		
1	Humanities and Social Sciences	4	3	-	-	-	-	2		09	**05.29**
2	Basic Sciences	12	4	4	2	-	-	-		22	**12.94**
3	Engineering Science	6	13	3	-	-	-	-		22	**12.94**
4	Professional Core	-	3	15	20	16	14.5	6	3	77.5	**45.58**
5	Professional Elective	-	-	-	-	3	6	6	3	18	**10.58**
6	Open Elective	-	-	-	-	3	-	3		6	**03.52**
7	Employability Enhancement Courses	1	2	-	-	-	2.5	-	10	15.5	**09.11**
	Total	**23**	**25**	**22**	**22**	**22**	**23**	**17**	**16**	**170**	**100%**

IP3151	INDUCTION PROGRAMME	L	T	P	C
		0	0	0	0

This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:
To train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.

"One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. "
Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and

allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing. Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering /Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

Induction Programme is totally an activity based programme and therefore there shall be no tests assessments during this programme.

SEMESTER I

U23HST11	COMMUNICATIVE ENGLISH (COMMON TO ALL B.E./ B.TECH. PROGRAMMES)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To enhance students listening ability for academic and Professional purposes.
2. To learn to use basic grammatical structures in suitable contexts
3. To help students acquire the ability to speak effectively in English in real -life situations.
4. To help learners use language effectively in professional contexts.
5. To develop student's ability to read and write complex texts, summaries, articles, definitions, Paragraph user manuals.

UNIT I INTRODUCTION TO EFFECTIVE COMMUNICATION 9

Define communication. Kinds of communication. Quintessential of communication in technical progression. Key characteristics of an effective communicator- listening, attitude modification, way of response with appropriate language, tone modulation.

Listening- Listening to TV news, Guest lectures. Speaking- Answering the Questions.

Reading - Reading brochures and technical magazines (technical context), telephone messages / social media messages relevant to technical contexts and emails, **Writing**-Reading comprehension, Parts of Speech.

UNIT II READING QUEST 9

Listening- listening and responding to video lectures/talks. **Speaking**- Day today conversations. **Reading** – Edison of India-GD Naidu "The Great Inventor". **Writing**- Emails / Informal Letters - Inviting, Congratulating & Thanking, Punctuations.

UNIT III LANGUAGE RESOURCE GROWS CRITICAL JUDGEMENT 9

Listening- listening to specific task-focused audio tracks. Speaking- summary of Robert Frost "Stopping by woods on a snowy evening". Reading – Reading advertisements, gadget reviews; user manuals. Writing – Essay Writing: Analytical essay: Narrative Essay, Developing Hints, Usage of tenses in sentence formation. Voices.

UNIT IV LANGUAGE IN LIFE SKILL 9

Listening- Listening to speech of Great Scholars. Speaking- mechanics of presentation. **Reading** – Newspaper articles, power point presentation. **Writing** – Checklist, Jumbled sentences-Rearrange the sentences in correct order, WH-Questions-Form questions by using statements, Prefixes and Suffixes.

UNITV IMPROVING SPEAKING &READING 9

Listening- listening to situational based dialogues; Speaking- Stating intention to do something- Expressing opinion-asking people to repeat themselves. Reading – Summary of O.Henry's "The last Leaf". Writing – Dialogue Writing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 : Remember appropriate words in a situational conversation.

CO2 : Gain understanding of basic grammatical structures and use them in right context.

CO3 : Read and infer the denotative and connotative meanings of technical texts.

CO4 : Write Dialogue, Letter and paragraphs on various topics.

CO5 : Make the students prepare effective notes for main sources available.

CO6 : Enhance them to give operational talk.

TEXT BOOKS:

1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition).
2. English for Science & Technology Cambridge University Press, 2021. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.
3. The Gift of the Magi by O.Henry, McClure,Philips and company.

REFERENCE BOOKS:

1. Technical Communication – Principles And Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book On Technical English By Lakshminarayanan, Scitech Publications (India) Pvt. Ltd.
3. English For Technical Communication (With CD) By Aysha Viswamohan, Mcgraw Hill Education.
4. Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
5 Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi,2003.

U23MAT12 **MATRICES AND CALCULUS**

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. To develop the use of matrix algebra techniques that is needed by engineers for practical Applications.
2. To familiarize the students with differential calculus.
3. To familiarize the student with functions of several variables
4. To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.
5. To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems

UNIT I MATRICES **12**

Introduction – Characteristic equation – Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors – Cayley Hamilton theorem – Diagonalization of the matrices by Orthogonal Transformations – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II DIFFERENTIAL CALCULUS **12**

Limit of a function – Continuity – Derivatives – Differentiation rules – Implicit differentiation – Logarithmic differentiation – Maxima and Minima of functions of one variable.

UNIT III MULTIVARIABLE CALCULUS **12**

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative –Jacobians – Taylor's series for functions of two variables – Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

UNITIV MULTIPLE INTEGRAL AND THEIR APPLICATIONS **12**

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

UNIT V ORDINARY DIFFERENTIAL EQUATIONS **12**

Higher order linear differential equations with constant coefficients– Method of variation of parameters – Homogenous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients – Method of undetermined coefficients.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Use the matrix algebra methods for solving practical problems.
CO2 : Use both the limit definition and rules of differentiation to differentiate functions.
CO3: Apply differential calculus tools in solving various application problems.
CO4: Able to use differential calculus ideas on several variable functions.
CO5: Apply multiple integral ideas in solving areas, volumes and other practical problems.

CO6: Solve the ordinary differential equations using different techniques for that model Engineering problems.

TEXT BOOKS:

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal. B.S., "Higher Engineering Mathematics",Khanna Publishers, New Delhi, 44th Edition, 2018.
3. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6 , 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].

REFERENCE BOOKS:

1. Bali. N., Goyal. M. and Watkins. C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt.,Ltd.,), New Delhi, 7th Edition, 2009.
2. Jain. R.K. and Iyengar. S.R.K., "Advanced Engineering Mathematics", Narosa Publications, NewDelhi, 5th Edition,2016.
3. Narayanan. S. and Manicavachagom Pillai. T. K.,"Calculus" Volume I and II, S.Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
4. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt.Ltd, New Delhi, 2016
5. Thomas. G. B., Hass. J, and Weir. M.D,"Thomas Calculus", 14th Edition, Pearson India, 2018.

U23PHT13	PHYSICS FOR ENGINEERS AND TECHNOLOGISTS (COMMON TO ALL B.E./ B.TECH. PROGRAMMES)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To make the students to gain the knowledge in elastics and plastic nature of the materials in the presence and absence of load.
2. To understand the students to know the application of the sound waves in different fields.
3. To motivate the students towards the applications of photo electric phenomena.
4. To know the physical principle of LASER, the working of LASER applications.
5. To understand the propagation of light in optical fibers and its applications.

UNIT I ELASTICITY **9**

Introduction- Elasticity - plasticity– Hooke's law - relationship between three Modulii of elasticity (Qualitative) – stress & strain diagram and its uses -Poisson's ratio - factors affecting elasticity - twisting ouple of wire - Torsion Pendulum: theory and experiment.

Beam: Internal bending moment – Cantilever: theory and experiment – Young's Modulus: uniform and non – uniform bending (Qualitative) – I-shaped girders- advantages and applications.

UNIT II ULTRASONICS **9**

Introduction – classification of sound- properties of infrasonic, audible and ultrasonics - production: Magnetostriction and Piezoelectric methods – determination of velocity of sound in liquid (Acoustic Grating Method) – general applications – industrial application: Non - Destructive Testing: pulse echo system through transmission and reflection modes. ultrasonic scanning methods – medical application: sonogram.

UNIT III MODERN PHYSICS **9**

Introduction –Black Body Radiation – Classical and Quantum Laws of Black Body Radiation - Photon and its Properties - Wave Particle Duality and Matter waves – De - Broglie Wavelength - Schrodinger's Time Independent and Time Dependent Wave Equations - Physical Significance of The Wave Function. Application: Particle in One Dimensional Box - Normalization Process – Photo Electric Effect – Laws Governing the Photoelectric Effect – Einstein's Formula - Derivation – Applications: Solar Cell – Solar Water Heater – Photo resistor (LDR).

UNIT IV LASERS **9**

Lasers: Introduction - Properties of Laser-Spontaneous and Stimulated Emission Process - Einstein's Theory of Matter Radiation Interaction & A and B Coefficients; Amplification of Light By Population Inversion – Pumping Methods - Types of Lasers: Solid-State Laser (Homo And Hetero Junction Semiconductor Lasers), Gas Laser (CO_2), Applications: Laser Cutting and Welding, LIDAR and Barcode Scanner.

UNIT V FIBER OPTICS AND APPLICATIONS **9**

Optical Fiber: Structure - advantages- Principle [TIR]–Propagation Phenomena in optical fiber - Expression For Acceptance Angle and Numerical Aperture – Relation between Refractive Index of Core, Numerical Aperture and Fractional Index Change – Fabrication: Double Crucible Method - Types: Material, Mode, Refractive Index - Applications: Optical Fiber Communication System – fiber optic sensors (Displacement and pressure sensors) – Medical Endoscope.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Differentiate the elastic and plastic nature of the materials.

CO2 : Know the experimental techniques in both production and applications of ultrasonic waves.

CO3: Gain knowledge in the basics of quantum mechanics concepts.

CO4: Develop new devices based on LASER source.

CO5: Understand the advantages of optical fiber than metal wire.

CO6: Demonstrate the some useful experiments based on optical fibre

TEXT BOOKS:

1. Dr. P.Mani, "Engineering Physics", Dhanam Publications, 2013.
2. Dr. G. Senthilkumar, "Engineering Physics", VRB Publishers, 2017.
3. K. Thyagarajan, Ajoy Ghatak, "Lasers Fundamentals and Applications" II nd Edition, Springer, 2010.
4. D.K. Bhattacharya, Poonam Tandon," Engineering Physics", Oxford HED Publishers, 2017.

REFERENCE BOOKS:

1. Marikani, "Engineering Physics", PHI, New Delhi, 2013.
2. Bhattacharya & Bhaskaran, "Engineering Physics", Oxford Publications, 2012.
3. R Murugeshan, Kiruthiga, Sivaprasath S, "Modern Physics", Chand Publishing, 2021.
4. S. Rajivgandhi & A. Ravikumar, " Engineering Physics I", RK Publications, 2023
5. Sathyaprakash, "Quantum Mechanics", Pragati Prakashan, Meerut, 2016.

U23CYT14	CHEMISTRY FOR ENGINEERING & TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To inculcate sound understanding of water quality parameters and water treatment techniques.
2. Impart knowledge on the basic principles and preparatory methods of nanomaterial.
3. To introduce the basic concepts and applications of phase rule and composites.
4. To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
5. Tofamiliarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

UNIT I Water Treatment 9

Water: Sources, impurities, Parameters. Types of water Hardness of water -types – expression of hardness – units – Estimationof hardness of water by EDTA. Desalination - Reverse Osmosis. Boiler troubles: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralisation and zeolite process.

UNIT II Electro and Nano chemistry 9

Electrochemical cells – reversible and irreversible cells – EMF – measurement of emf by Poggendorff's compensation principle. Single electrode potential – Nernst equation – reference electrodes -types– Calomel electrode - electrolysis of water.

Nanomaterials Basics of Nano Chemistry: Distinction between molecules, nanomaterials and bulkmaterials. Preparation of nanomaterials- laser ablation method and Chemical VapourDeposition(CVD). Application of Nanomaterials in medicine, agriculture, energy, electronics and catalysis.

UNIT III Phase Rule and Composites 9

Phase rule terms with examples. Water system; Reduced phase rule Two component system: lead-silver system – Composites, Need, and Constitution: Matrix materials, Applications and Reinforcement and applications of Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites - definition and examples.

UNIT IV Fuels & Combustion 9

Fuels –Classification-Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; Power alcohol and biodiesel.

Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method. CO_2 emission and carbon foot print.

UNIT V Energy Sources and Storage devices 9

Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion- battery; Electric vehicles-working principles; Fuel cells: H_2-O_2 fuel cell, microbial fuel cell; Supercapacitors: Storage principle, types and examples.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Develop innovative methods to produce soft water for industrial use and potable water at cheaper cost.

CO2 : Apply the basic knowledge of Corrosion and various electrodes.

CO3: Know the economically and new methods of synthesis nano materials.

CO4: Apply the knowledge of phase rule and composites for material selection requirements.

CO5: Understand the concepts ofsuitable fuels for engineering processes and applications.

CO6: Have the knowledgeof different forms of energy resources and apply them for suitable applicationsin energy sectors.

TEXT BOOKS:

1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition, DhanpatRai Publishing Company (P) Ltd, New Delhi, 2018.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3. S.S. Dara, "A text book of Engineering Chemistry", S. Chand Publishing, 12th Edition, 2018.
4. J.Manivel , "Engineering Chemistry" R.K.Publishers, 1st Edition 2022.

REFERENCE BOOKS:

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text book of nanoscience and nanotechnology", Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
4. ShikhaAgarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019.

U23GET16	ENGINEERING GRAPHICS	L	T	P	C
		2	0	4	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To develop in students, graphic skills for communication of concepts, ideas and design of engineering products.
2. To expose them to existing national standards related to technical drawings.
3. Develop proficiency in 2D drafting using drawing tools.
4. Learn sectional views and assembly drawing techniques.
5. Enhance visualization skills for improved problem-solving and communication in engineering.

UNIT I PLANE CURVES AND ORTHOGRAPHIC PROJECTION 6+12

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimension. Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three-Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects.

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE 6+12

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 (polygonal and circular surfaces) inclined to both the planes.

UNIT III PROJECTION OF SOLIDS 6+12

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 6+12

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple solids – Prisms, pyramids cylinders and cones.

UNITV ISOMETRIC PROJECTION 6+12

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions-Perspective Projection.

TOTAL: 30+40=90 PERIODS

COURSE OUTCOMES:

At the end ofthe course thestudentswouldbeableto

CO1 : Identify the significance of graphics in engineering applications.

CO2 : Project straight lines inclined to both principal planes and determine true lengths and inclinations.

CO3: Apply orthographic projection techniques to project solids.

CO4: Apply the principles of development to prisms, pyramids, cylinders, and cones.

CO5: Combine two solid objects in simple vertical positions using isometric projection.

CO6: Utilize the isometric scale effectively.

TEXT BOOKS:

1. Natrajan K.V., ―A text book of Engineering Graphics‖, Dhanalakshmi Publishers, Chennai, 2009.
2. Venugopal K. and Prabhu Raja V., ―Engineering Graphics‖, New Age International (P) Limited, 2008

REFERENCE BOOKS:

1. Bhatt N.D. and Panchal V.M., ―Engineering Drawing‖, Charotar Publishing House, 50th Edition, 2010.
2. Basant Agarwal and Agarwal C.M., ―Engineering Drawing‖, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
3. Gopalakrishna K.R., ―Engineering Drawing‖ (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
4. Luzzader, Warren.J. andDuff,John M., ―Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
6. N S Parthasarathy and Vela Murali, ―Engineering Graphics‖, Oxford University, Press, New Delhi, 2015.

GE3152	HERITAGE OF TAMILS	L	T	P	C
		1	0	0	1

UNIT I LANGUAGE AND LITERATURE 3

Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils

UNIT III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNITV CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL: 15 PERIODS

TEXT-CUM-REFERENCE BOOKS:

1. தமிழகவரலாறு – மக்களும்பண்பாடும் – கேகேபிள்ளை (வெளியீடு: தமிழ்நாடுபாடநூல்மற்றும்கல்வியியல்பணிகள்கழகம்).
2. கணினித்தமிழ் – முனைவர்இல. சுந்தரம். (விகடன்பிரசுரம்).
3. கீழடி – வைகைநதிக்கரையில்சங்ககாலநகரநாகரிகம் (தொல்லியல்துறைவெளியீடு)
4. பொருநை – ஆற்றங்கரைநாகரிகம் (தொல்லியல்துறைவெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International

Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

U23BSP11	PHYSICS AND CHEMISTRY LABORATORY (COMMON TO ALL B.E. / B.TECH. PROGRAMMES)	L	T	P	C
		0	0	3	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To learn the proper use of various kinds of physics laboratory equipment.
2. To learn how data can be collected, presented and interpreted in a clear and concise manner.
3. To learn problem solving skills related to physics principles and interpretation of experimental data.
4. To determine error in experimental measurements and techniques used to minimize such error.
5. To make the student as an active participant in each part of all lab exercises.
6. To inculcate experimental skills to test basic understanding of water quality parameters, as, acidity, alkalinity, chloride.
7. To Induce the students to analyze the hardness of water
8. To induce the students to familiarize with electro analytical techniques such as, pH metry, conductometry in the determination of impurities in aqueous solutions.

LIST OF EXPERIMENTS

1. Torsion pendulum - Determination of rigidity modulus of wire and moment of inertia of regular disc.
2. Non - Uniform bending–Determination of Young's modulus.
3. Laser – (i) Determination of the wavelength of the laser using grating.
   (ii) Determination of size of the particles using laser source.
4. Air wedge – Determination of thickness of a thin sheet/wire.
5. Determination of Band gap of a semiconductor using PN junction kit.
6. To study the V-I Characteristics of Light Dependent Resistor (LDR).
7. Determination of types and amount of alkalinity in water sample.
8. Determination of total, temporary & permanent hardness of water by EDTA method.
9. Determination of chloride content of water sample by Argentometric method.
10. Determination of strength of given hydrochloric acid using pH meter.
11. Determination of strength of acids in a mixture of acids using conductivity meter.
12. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Torsion pendulum set up (Metal Disc, Symmetrical Mass(2x100g), Stop Clock, Screw Gauge)	**5**
2.	Non – Uniform bending set up (Travelling Microscope, Knife Edges, Weight Hanger with Mass(5x50g), Screw Gauge, Vernier Caliper, Meter Scale)	**5**
3.	Laser set up (Semiconductor Laser, Screen, Grating Stand, Wooden Stand With Meter Scale)	**5**
4.	Air wedge (Air Wedge Set Up, Travelling Microscope, Sodium Vapour Lamp, Transformer)	**5**
5.	Band gap of a semiconductor (PN Junction Kit, Thermometer, Heater, Beaker, Oil)	**5**

6.	Light Dependent Resistor (Power Suppy, Voltmeter, Ammeter, LDR, Bulb, Resistors)	**5**
7.	PH meter	**5**
8.	Conductivity meter	**10**
9.	Common Apparatus(Pipette, Burette, Conical Flask, Porcelain tile, Dropper)	**15**

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Understand the functioning of various physics laboratory equipment.
CO2 :	Observe and tabulate experimental data.
CO3:	Solve problems individually and collaboratively.
CO4:	Analyse the quality of water samples with respect to their acidity, alkalinity
CO5:	Determine the amount of hardness in the water
CO6:	Analyse quantitatively the impurities in solution by electro analytical techniques

U23HSP12	ENGLISH LABORATORY	L	T	P	C
	(COMMON TO ALL B.E. / B.TECH. PROGRAMMES)	0	0	2	1

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To improve the communicative competence of learners.
2. To help learners use language effectively in academic /work contexts.
3. To develop various listening strategies to comprehend various types of audio materials like lectures, discussions, videos etc.
4. To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that is relevant to authentic contexts.
5. To use language efficiently in expressing their opinions via various media.

LIST OF EXPERIMENTS

1. Listening for general information-specific details.
2. Conversation: Introduction to classmates.
3. Speaking - making telephone calls-Self Introduction.
4. Talking about current and temporary situations & permanent and regular situations.
5. Listening to podcasts, anecdotes / stories / event narration.
6. Event narration; documentaries and interviews with celebrities.
7. Events-Talking about current and temporary situations & permanent and regular situations.
8. Engaging in small talk.
9. Describing requirements and abilities- Picture description.
10. Discussing and making plans.
11. Talking about tasks- progress- positions -directions of movement.
12. Talking about travel preparations and transportation.
13. Listening to debates/ discussions.
14. Making prediction talking about a given topic.
15. Describing processes.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Communication laboratory with sufficient computer systems	**30**
2.	Server	**1**
3.	Head phone	**30**
4.	Audio mixture	**1**
5.	Collar mike	**1**
6.	Television	**1**
7.	Speaker set with amplifier	**1**
8.	Power point projector and screen	**1**
9.	Cordless mike	**1**

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Identify and comprehend complex academic texts.

CO2 : Interpret accurately and fluently in formal and informal communicative contexts.

CO3: Demonstrate their opinions effectively in both oral and written medium of communication.

CO4: Plan travelogue and construct paragraphs on various aspects.

CO5: Develop journal reading skills and small talk.

CO6: Utilizing technical terms and making power point presentations.

U23GEP14 ENGINEERING PRACTICES LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES:

The main learning objective of this course is to provide hands on training to the students in:

1. Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in common house hold wood work.
2. Wiring various electrical joints in common household electrical wire work.
3. Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts;
4. Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.
5. Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.

GROUP – A (CIVIL AND MECHANICAL)

PART I CIVIL ENGINEERING PRACTICES PLUMBING WORK: 30

a. Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
b. Preparing plumbing line sketches.
c. Laying pipe connection to the suction side of a pump
d. Laying pipe connection to the delivery side of a pump.
e. Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

WELDING WORK:

a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
b) Practicing gas welding.

BASIC MACHINING WORK:

a) Turning
b) Drilling
c) Tapping

ASSEMBLY WORK:

a) Assembling a centrifugal pump.
b) Assembling a household mixer.

SHEET METAL WORK:

a) Making of a square tray

WOOD WORK:

a. Sawing,
b. Planing and
c. Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

PART II ELECTRICAL & ELECTRONICS 30

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring
4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5. Measurement of energy using single phase energy meter.
6. Measurement of resistance to earth of an electrical equipment.

ELECTRONICS

1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.

2. Study of logic gates AND, OR, EX-OR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components Devices and Circuits Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

TOTAL = 60 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

CIVIL

1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings. 15Sets.
2. Carpentry vice (fitted to work bench) 15Nos.
3. Standard woodworking tools 15 Sets.
4. Models of industrial trusses, door joints, furniture joints 5each
5. Power Tools: (a) Rotary Hammer 2 Nos (b) Demolition Hammer 2 Nos (c) Circular Saw 2 Nos (d) Planer 2 Nos (e) Hand Drilling Machine 2 Nos (f) Jigsaw 2Nos

MECHANICAL

Arc welding transformer with cables and holders 5 Nos.

1. Welding booth with exhaust facility 5Nos.
2. Welding accessories like welding shield, chipping hammer, wire brush, etc. 5Sets.
3. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit. 2Nos.
4. Centre lathe 2Nos.
5. Hearth furnace, anvil and smithy tools 2Sets.
6. Moulding table, foundry tools 2Sets.
7. Power Tool: Angle Grinder 2Nos
8. Study-purpose items: centrifugal pump, air-conditioner Oneeach

ELECTRICAL

1. Assorted electrical components for house wiring 15Sets
2. Electrical measuring instruments 10Sets
3. Study purpose items: Iron box, fan and regulator, emergency lamp 1 each
4. Megger (250V/500V) 1No.
5. Power Tools:
   a) Range Finder 2Nos
   b) Digital Live-wire detector 2Nos

ELECTRONICS

1. Soldering guns 10Nos.
2. Assorted electronic components for making circuits 50Nos.
3. Small PCBs 10Nos.
4. Multimeters 10Nos.

Study purpose items: Telephone, FM radio, low-voltage power supply.

COURSE OUTCOMES:

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

CO1 : Draw pipe line plan; lay and connect various pipe fittings used in common household plumbingwork; Saw; plan; make joints in wood materials used in common household wood work.

CO2 : Wire various electrical joints in common household electrical wire work.

CO3: Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common Householdequipments; Make a tray out of metal sheet using sheet metal work.

CO4: Solder and test simple electronic circuits; Assemble and test simple electronic components onPCB.

CO5: Apply fundamental engineering principles to analyze and solve real-world problems.

CO6: Demonstrate proficiency in using engineering tools and equipment.

SEMESTER II

		L	T	P	C
U23HST21	PROFESSIONAL ENGLISH (COMMON TO ALL B.E. / B.TECH. PROGRAMMES)	3	0	0	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To engage learners in meaningful language activities to improve their reading and writing skills.
2. To learn various reading strategies and apply in comprehending documents in professional context.
3. To help learners understand the purpose, audience, contexts of different types of writing.
4. To enable students write letters and reports effectively in formal and business situations.
5. To demonstrate an understanding of job applications and interviews for internship and placements.

UNIT I PREPARATORY DOCUMENTATIONS 9

Listening- Listening to formal conversations and Participating**. Speaking-** speaking about one's family. **Reading –** Summary of W.W Jacobs "The monkey's paw". **Writing –** Subject verb Agreement, Numerical -Adjectives, Kinds of sentences**,** Writing reviews (book / film),writing Instructions, Writing Recommendation.

UNIT II LECTURA ENRICHMENT AND PASSAGE COMPOSE 9

Listening- listening to lectures on academic topics; **Speaking-** Asking for and giving directions. **Reading -** Reading longer technical texts; **Writing -** Compound words, Homophones and Homonyms, Cause and Effect expressions. Essay Writing, Writing Letter to the Editor (complaint, acceptance, Requesting, Thanking).

UNIT III ANALYTICAL SKILL 9

Listening- Watching videos/documentaries and responding to questions based on them. **Speaking –** Speaking about ones favourite place**. Reading –** Summary of the poem – John keats "Ode to a Nightingale". **Writing-** Purpose statement, Extended Definitions. Writing Job/ Internship application – Cover letter & Resume.

UNIT IV REPORT WRITING 9

Listening- Listening to class room lectures/talks on engineering/technology. **Speaking–** Introduction to technical presentations. **Reading –** Newspaper articles; **Writing –** Comparative Adjectives Direct and Indirect speech**.** Report Writing- Fire Accident Report, Road Accident, Feasibility Report).

UNITV ENABLING LINGUA IDEALITY & INFORMATION 9

Listening- TED/Ink talks. **Speaking –** Making presentation on a given topic. **Reading –**Company profiles, Statement of Purpose, (SOP), **Writing –** Relative Clauses, If conditions, Cause and Effect. Chart Interpretations - Bar Chart, Pie Chart, Flow Chart & Tables.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Compare and contrast products and ideas in technical texts.

CO2 : Identify cause and effects in events, industrial processes through technical texts.

CO3 : Analyze problems in order to arrive at feasible solutions and communicate them orally and in the written format.

CO4 : Motivate students to write reports and winning job applications.

CO5 : Recall and comprehend different discourses and genres of texts.

CO6 : Making the students to become virtuous presenters.

TEXT BOOKS:

1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2. English for Science & Technology Cambridge University Press 2021.
3. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

REFERENCE BOOKS:

1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, New Delhi.
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.

U23MAT22	STATISTICS AND NUMERICAL METHODS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. This course aims at providing the necessary basic concepts of a few statistical tools and give procedures for solving different kinds of problems occurring in engineering and technology.
2. To acquaint the knowledge of classifications of design of experiments in the field of agriculture.
3. To introduce the basic concepts of solving algebraic and transcendental equations.
4. To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
5. To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT I TESTING OF HYPOTHESIS 12

Introduction – Sampling distributions – Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

UNIT II DESIGN OF EXPERIMENTS 12

Introduction – Analysis of variance – One way and two way classifications – Completely randomized design – Randomized block design – Latin square design.

UNIT III SOLUTION OF EQUATIONS AND EIGEN VALUE ROBLEMS 12

Solution of algebraic and transcendental equations – Fixed point iteration method – Newton Raphson method – Solution of linear system of equations – Gauss elimination method – Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigen Value of a matrices by power method and jacobi's method for Symmetric matrices.

UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION 12

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 12

Single step methods : Taylor's series method – Euler's method – Modified Euler's method – Fourth order Runge – Kutta method for solving first order differential equations – Multi step methods: Milne's and Adams Bashforth predictor corrector methods for solving first order differential equations.

TOTAL:60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 :	Apply the concept of testing of hypothesis for small and large samples in real life problems.
CO2 :	Apply the basic concepts of classifications of design of experiments in the field ofagriculture.
CO3:	Solve the algebraic and transcendental equations.
CO4:	Understand the knowledge of numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.
CO5:	Solve the ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.
CO6:	Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.

TEXT BOOKS:

1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
2. Johnson , R.A., Miller, I and Freund J., “Miller and Freund’s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

REFERENCES BOOKS :

1. Burden,R.L and Faires, J.D, "Numerical Analysis”, 9th Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences”, Cengage Learning, New Delhi , 8th Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis” Pearson Education, Asia, New Delhi, 7th Edition, 2007.
4. Gupta S.C. and Kapoor V.K., “Fundamentals of Mathematical Statistics”, Sultan Chand & Sons, New Delhi,12th Edition, 2020.
5. Spiegel.M.R.,Schiller.J. and Srinivasan. R.A., "Schaum’s Outlines on Probability and Statistics", Tata McGraw Hill Edition, 4th Edition, 2012.

U23GET15	PROBLEM SOLVING AND PYTHON PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To understand the basics of algorithmic problem solving.
2. To learn to solve problems using Python conditionals and loops.
3. To define Python functions and use function calls to solve problems.
4. To use Python data structures - lists, tuples, dictionaries to represent complex data.
5. To do input/output with files in Python.

UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING 9

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II DATA TYPES, EXPRESSIONS, STATEMENTS 9

Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III CONTROL FLOW, FUNCTIONS, STRINGS 9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else),chained conditional (if-elif-else);Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

UNITV FILES, MODULES, PACKAGES 9

Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Develop algorithmic solutions to simple computational problems.
- **CO2 :** Develop and execute simple Python programs.
- **CO3 :** Write simple Python programs using conditionals and loops for solving problems.
- **CO4 :** Decompose a Python program into functions.
- **CO5 :** Represent compound data using Python lists, tuples, dictionaries etc.
- **CO6 :** Read and write data from/to files in Python programs.

TEXT BOOKS:

1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.
3. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
4. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.

REFERENCE BOOKS:

1. John V Guttag, "Introduction to Computation and Programming Using Python'", Revised and expanded Edition, MIT Press , 2013
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach", Pearson India Education Services Pvt. Ltd., 2016.
3. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012.
4. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus", Wiley India Edition, 2013.

		L	T	P	C
U23PHT24	PHYSICS FOR ELECTRICAL AND ELECTRONICS ENGINEERS (COMMON TO EEE AND ECE PROGRAMMES)	3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To make the students to understand the basics of crystallography and its importance in studying materials properties.
2. To expand their knowledge in applications of magnetic and superconducting materials in small scale industries.
3. Tomakethestudentstounderstandthebasicsofdielectricmaterials andinsulation.
4. To inculcate an idea of significance of new materials, nanostructures ensuing nano device applications.
5. To know the basic building of electronic circuits using gates.

UNIT I CONDENSED MATTER PHYSICS 9

Introduction - Lattice - Unit Cell - Seven Crystal Systems -Bravai's Lattices - Lattice Planes - Calculation of Number of Atoms per Unit Cell, Atomic Radius, Coordination Number and Packing Factor for SC, BCC, FCC and HCP Structures. Miller Indices – Derivation for Inter-Planar Spacing in terms of Miller Indices-Crystal Growth Techniques: Melt Growth Technique (Bridgman and Czochralski Techniques).

UNIT II MAGNETIC AND SUPERCONDUCTING MATERIALS 9

Magnetic Materials: Dia, Para and Ferromagnetic Materials and Its Properties – Ferromagnetic Domains – Wiess Theory of Ferromagnetism – Hysteresis - B-H Curve Studies – Soft and Hard Magnetic Materials-Applications.Superconducting Materials: Properties – Messiner effect-Type I and Type II Superconductors – London equations – High temperature super conductor – Applications: SQUIDS- Magnetic Levitated Train.

UNIT III DIELECTRIC AND FERRO ELECTRIC MATERIALS 9

Introduction – Basic Definitions - Types of Polarization Mechanisms - Langevin- Debye Equation - Internal Field – Clausius - Mossotti Relation - Dielectric Loss – Dielectric Breakdown– Applications of Dielectric Materials.

Ferro Electric Materials: Properties – Ferromagnetic Hysteresis – Properties- Applications.

UNIT IV MODERN ENGINEERING MATERIALS 9

Shape Memory Alloys – Structures – Types – Properties – Applications. Metallic Glasses – Types – Preparation, properties and Applications. Ceramics – Types - Properties and Applications.

UNIT V NANOMATERIALS 9

Nanomaterials – quantum confined nano structures and its derivations – Properties and Applications – Preparation Techniques: Electrodeposition – Pulsed Laser Deposition. Carbon nano tubes – Structure – Types – Properties – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Know basics of crystallography and its importance for varied materials properties.

CO2 : Gain knowledge on the magnetic and super conductor properties of materials and their applications.

CO3: Use the dielectric and insulating materials in electronic devices.

CO4: Illustrate the SMA and metallic glasses.

CO5: Get knowledge on newly developed materials in micro and nano scale.

CO6: Summarize the different structures of CNT in Nano range

TEXT BOOKS:

1. Charles Kittel, Introduction to Solid State Physics, Wiley India Edition, 2019.
2. G.W.Hanson.FundamentalsofNanoelectronics.PearsonEducation(IndianEdition) 2009.
3. Dr. P. Mani, “Physics for Electronics Engineering” Dhanam Publications, 2017.
4. Dr. G. Senthilkumar, “Engineering Physics II” VRB Publishers, 2013.
5. Theraja .B.L., Basic electronics solid state, S.Chand and Company Ltd (2002).

REFERENCE BOOKS:

1. R.Balasubramaniam, Callister’s Materials Science and Engineering. Wiley (Indian Edition), 2014.
2. Robert F.Pierret, Semiconductor Device Fundamentals, Pearson, 2006.
3. Dr. G. Senthilkumar, A. Ravikumar & S. Rajivgandhi, “ Engineering Physics II”, VRB Publishers, 2023
4. Ben Rogers, Jesse Adams and Sumita Pennathur, Nanotechnology: Understanding Small Systems, CRC Press, 2017.
5. Sedha R.S., A text book of applied Electronies, S.Chand & company Ltd (2002).
6. S. O. Pillai, “Solid State Physics”, New Age International, New Delhi, 1995

U23MET25 BASIC CIVIL AND MECHANICAL ENGINEERING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To provide the students an illustration of the significance of the Civil and Mechanical Engineering Profession in satisfying the societal needs.
2. To help students acquire knowledge in the basics of surveying and the materials used for construction.
3. To provide an insight to the essentials of components of a building and the infrastructure facilities.
4. To explain the component of power plant units and detailed explanation to IC engines their working principles.
5. 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 CivilEngineering – Structural, Construction, Geotechnical, Environmental, Transportation and WaterResources Engineering – National building code – terminologists: Plinth area, Carpet area, Floorarea, 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 ofSociety –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.

UNITV REFRIGERATION AND AIR CONDITIONING SYSTEM 9

Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system – Layout of typical domestic refrigerator – Window and Split type room Air conditioner. Properties of air - water mixture, concepts of psychometric and its process.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end ofthe course thestudentswouldbeableto

CO1 : Understanding profession of Civil engineering.
CO2 : Understanding profession of Mechanical engineering.
CO3: Summarise the planning of building, infrastructure and working of Machineries.
CO4: Apply the knowledge gained in respective discipline
CO5: Illustrate the ideas of Civil and Mechanical Engineering applications.
CO6: Appraise the material, Structures, machines and energy.

TEXT BOOKS:

1. G Shanmugam, M S Palanichamy, Basic Civil and Mechanical Engineering, McGraw Hill Education; First edition, 2018.
2. Palanikumar, K. Basic Mechanical Engineering, ARS Publications, 2018.
3. Ramamrutham S., "Basic Civil Engineering", Dhanpat Rai Publishing Co.(P) Ltd, 2013.

REFERENCE BOOKS:

1. Seetharaman S., "Basic Civil Engineering", Anuradha Agencies, 2005.
2. Shantha Kumar SRJ., "Basic Mechanical Engineering", Hi-tech Publications, Mayiladuthurai,2000.

U23EET21	ELECTRIC CIRCUIT ANALYSIS	L	T	P	C
		3	1	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To introduce Electric circuits and its analysis
2. To impart knowledge on solving circuit equations using network theorems
3. To educate on obtaining the transient response of circuits.
4. To introduce the phenomenon of resonance in coupled circuits.
5. To analyze the three phase circuits and basic concepts two port netwoks

UNIT I BASIC CIRCUITS ANALYSIS **9**

Fundamentals concepts of R, L and C elements-Energy Sources- Ohm's Law - Kirchhoff 's Laws – DC Circuits – Resistors in series and parallel circuits - A.C Circuits – Average and RMS Value –Real and Reactive Power, Power Factor, Energy –Mesh current and node voltage methods of analysis D.C and A.C Circuits.

UNIT II NETWORK REDUCTION AND THEOREMS **9**

Network reduction: voltage and current division, source transformation – star delta conversion.
Theorems – Superposition, Thevenin's and Norton's Theorem – Maximum power transfer theorem – Reciprocity Theorem – Millman's theorem

UNIT III TRANSIENT RESPONSE ANALYSIS **9**

Introduction – Laplace transforms and inverse Laplace transforms- standard test signals –Transient response of RL, RC and RLC circuits using Laplace transform for DC input and A.C. sinusoidal input.

UNIT IV RESONANCE AND COUPLED CIRCUITS **9**

Series and parallel resonance –frequency response – Quality factor and Bandwidth – Self and mutual inductance – Coefficient of coupling – Dot ruleAnalysis of coupled circuits– Single Tuned circuits.

UNITV THREE PHASE CIRCUITS **9**

Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced and unbalanced – phasor diagram of voltages and currents – power measurement in three phase circuits– Power Factor Calculations.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end ofthe course the students would be able to

CO1:	Explain circuit's behavior using circuit laws.
CO2:	Apply mesh analysis/ nodal analysis / network theorems to determine behavior of the given DC and AC circuit
CO3:	Compute the transient response of first order and second order systems to DC input
CO4:	Compute the transient response of first order and second order systems to AC input
CO5:	Compute power, line/ phase voltage and currents of the given three phase circuit
CO6:	Explain the behavior of magnetically coupled circuits.

TEXT BOOKS:

1. William H. HaytJr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis",McGraw Hill publishers, 9thedition, New Delhi, 2020.
2. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", Second Edition, McGraw Hill, 2019.
3. Allan H. Robbins, Wilhelm C. Miller, "Circuit Analysis Theory and Practice", Cengage Learning India, 2013

REFERENCE BOOKS:

1. Chakrabarti A, "Circuits Theory (Analysis and synthesis), Dhanpat Rai& Sons, New Delhi, 2020.
2. Joseph A. Edminister, Mahmood Nahvi, "Electric circuits", Schaum's series, McGraw-Hill, First Edition, 2019.
3. M E Van Valkenburg, "Network Analysis",Prentice-Hall of India Pvt Ltd, New Delhi, 2015.
4. Richard C. Dorf and James A. Svoboda, "Introduction to Electric Circuits", 7th Edition, John Wiley Sons, Inc. 2018.
5. Sudhakar A and Shyam Mohan SP, "Circuits and Networks Analysis and Synthesis", McGraHill, 2015.

GE3252	தமிழரும் தொழில்நுட்பமும் / TAMILS AND TECHNOLOGY	L	T	P	C
		1	0	0	1

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions inSilappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and otherworship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- hirumalaiNayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY 3

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold-Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL: 15 PERIODS

TEXT-CUM-REFERENCE BOOKS:

1. தமிழகவரலாறு – மக்களும்பண்பாடும் – கேகேபிள்ளை (வெளியீடு: தமிழ்நாடுபாடநூல்மற்றும்கல்வியியல்பணிகள்கழகம்).
2. கணினித்தமிழ் – முனைவர்இல. சுந்தரம். (விகடன்பிரசுரம்).
3. கீழடி – வைகைநதிக்கரையில்சங்ககாலநகரநாகரிகம் (தொல்லியல்துறைவெளியீடு)
4. பொருநை – ஆற்றங்கரைநாகரிகம் (தொல்லியல்துறைவெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International

Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

U23EEP21	ELECTRIC CIRCUITS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Gaining practical experience on electric circuits
2. Verifying the fundamental electrical laws
3. Verifying the various electrical theorems for the given DC/AC circuit
4. Analyzing transient behavior of the given RL/RC/RLC circuit
5. Simulating various electric circuits using Pspice/ Matlab/e-Sim / Scilab

LIST OF EXPERIMENTS

1. Simulation and experimental verification of series and parallel electrical circuit using Fundamental laws.
2. Simulation and experimental verification of electrical circuit problems using Thevenin's theorem.
3. Simulation and experimental verification of electrical circuit problems using Norton's theorem.
4. Simulation and experimental verification of electrical circuit problems using Superposition theorem.
5. Simulation and experimental verification of Maximum Power transfer theorem.
6. Simulation and Experimental validation of R-C,R-L and RLC electric circuit transients
7. Simulation and Experimental validation of frequency response of RLC electric circuit.
8. Design and implementation of series and parallel resonance circuit for a given frequency.
9. Simulation and experimental verification of three phase balanced and unbalanced star,delta networks circuit (Power and Power factor calculations).
10. PCB board implementation of DC/AC circuits.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	10 Nos of PC loaded with Pspice/ Matlab/e-Sim / Scilab/ Equivalent Software Package	Min. 10 users
2.	Printer	1
3.	Regulated Power Supply (0-30V)	15
4.	Function Generator (MHz Range)	5
5.	Oscilloscope (20 MHz)	10
6.	Digital Storage Oscilloscope (20 MHz)	2
7.	AC/DC – Voltmeters of required rating	10
8.	AC/DC -Ammeters of required rating	10
9.	Multimeters	10
10.	Decade Resistance Box, Decade Inductance Box, Decade Capacitance Box	6
11.	Single Phase Wattmeter of suitable rating	5
12.	Circuit Connection Boards -	20
13.	Connecting Wires	Necessary Quality
14.	Three phase star& delta connected load / Single phase load bank of suitable rating	3

15. Necessary Quantities of Resistors, Inductors, Capacitors of various capacities (Quarter Watt to 10 Watt)

COURSE OUTCOMES:

At the end ofthe course thestudentswouldbeableto

CO1 :	Use simulation and experimental methods to verify the fundamental electrical laws for the given DC/AC circuit (Ex 1)
CO2 :	Use simulation and experimental methods to verify the various electrical theorems for the given DC/AC circuit
CO3:	Analyze transient behavior of the given RL/RC circuit using simulation and experimental methods
CO4:	Analyze transient behavior of the given RLC circuit using simulation and experimental methods
CO5:	Analyze frequency response of the given series and parallel RLC circuit using simulation and experimentation methods
CO6:	Analyze the performance of the given three-phase circuit using simulation and experimental methods

U23HSP22	COMMUNICATION LABORATORY	L	T	P	C
		0	0	2	2

(COMMON TO ALL B.E. / B.TECH. PROGRAMMES)

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
2. To be able to communicate effectively through writing.
3. Encouraging plan designing and decision making.
4. Understanding and writing technical instruction.
5. To understand the value of letter writing with correct format.

LIST OF EXPERIMENTS:

1. Speaking-Role Play Exercises Based on Workplace Contexts.
2. Talking about competition.
3. Discussing progress toward goals-talking about experiences.
4. Discussing likes and dislikes.
5. Discussing feelings about experiences.
6. Discussing imaginary scenarios.
7. Writing short essays.
8. Speaking about the natural environment.
9. Describing communication system.
10. Describing position and movement- explaining rules.
11. Understanding technical instructions-Writing: writing instructions.
12. Speaking: describing things relatively-describing clothing.
13. Discussing safety issues (making recommendations) talking about electrical devices.
14. Describing controlling actions.
15. Writing a job application (Cover letter + Resume).

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Communication laboratory with sufficient computer systems	**30**
2.	Server	**1**
3.	Head phone	**30**
4.	Audio mixture	**1**
5.	Collar mike	**1**
6.	Television	**1**
7.	Speaker set with amplifier	**1**
8.	Power point projector and screen	**1**
9.	Cordless mike	**1**

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 : Distinguish their technical competency through language skill.

CO2 : Predict context effectively in-group discussions held in a formal / semi-formal discussions.

CO3: Understanding candidates' key characteristics.

CO4: Finding personality traits by sharing and comparing thoughts and ability.

CO5: Understanding the value of ethics.(rules and regulations).

CO6: Construct emails and effective job applications**.**

		L	T	P	C
U23GEP13	**PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY**	**0**	**0**	**4**	**2**

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To understand the problem solving approaches.
2. To learn the basic programming constructs in Python.
3. To practice various computing strategies for Python-based solutions to real world problems.
4. To use Python data structures - lists, tuples, dictionaries.
5. To do input/output with files in Python.

LIST OF EXPERIMENTS

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)
8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (divide by zero error, voter's age validity, student mark range validation)
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Intel Desktop System With Suitable software	30

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Develop algorithmic solutions to simple computational problems

CO2 : Develop and execute simple Python programs.

CO3: Implement programs in Python using conditionals and loops for solving problems.

CO4: Deploy functions to decompose a Python program.

CO5: Process compound data using Python data structures.

CO6: Utilize Python packages in developing software applications.

SEMESTER III

		L	T	P	C
U23MAT31	**TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students:

1. To introduce the basic concepts of PDE for solving standard partial differential equations.
2. To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
3. To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
4. To acquaint the student with Fourier transform techniques used in wide variety of situations.
5. To enable the students to study the Laplace transforms and some applications to solve the differential equations.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Lagrange's linear equation – Solution of homogeneous linear partial differential equations of higher order with constant coefficients of both homogenous and non – homogenous type.

UNIT II FOURIER SERIES 9

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

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9

Classification of PDE – Method of separation of variables - Fourier series solutions of one dimensional wave equation — One dimensional equation of heat conduction — Steady state solution of two dimensional equation of heat conduction (Cartesian coordinates only).

UNIT IV FOURIER TRANSFORMS 9

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

UNITV LAPLACE TRANSFORMS 9

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems – Transforms of derivatives and integrals - Initial and final value theorems – Inverse transforms – Convolution theorem–Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students would be able to

CO1: Understand how to solve the given standard partial differential equations.

CO2: Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.

CO3: Appreciate the physical significance of Fourier series techniques in solving One and two dimensional heat flow problems and one dimensional wave equations.

CO4: Understand the mathematical principles on transforms would provide them the ability to formulate and solve some of the physical problems of engineering.

CO5: Use the method of Laplace Transform to solve initial value problem for Linear

differential equations with constant coefficients.

CO6: Understand how to solve the given linear second order differential equations.

TEXT BOOKS:

1. Grewal B.S., “Higher Engineering Mathematics", 44thEdition, Khanna Publishers, New Delhi ,2018.
2. Kreyszig E, "Advanced Engineering Mathematics", 10th Edition, John Wiley,New Delhi,India,2016.

REFERENCE BOOKS:

1. Andrews. L.C and Shivamoggi .B, "Integral Transforms for Engineers "SPIE Press,1999.
2. Bali. N.P and Manish Goyal, "A Text book of Engineering Mathematics", 10th Edition, Laxmi Publications Pvt. Ltd ,2015.
3. James. G., "Advanced Modern Engineering Mathematics", 4th Edition, Pears on Education, New Delhi,2016.
4. Narayanan. S.,Manicavachagom Pillay. T.K and Ramanaiah. G "Advanced Mathematics for Engineering Students",Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd,NewDelhi,2018.

U23EET31	MEASUREMENT AND INSTRUMENTATION SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Electrical & electronic instruments and measurements techniques.
2. Calibration of meters.
3. Measurement of Capacitance, Inductance and Resistance.
4. Measurement of Magnetic parameters, and Electronics Instruments
5. Errors and standards of instruments

UNIT I CHARACTERISTICS, ERRORS & STANDARDS OF INSTRUMENTS 9

Functional elements of generalized Instrumentation Systems-Static and Dynamic characteristics: Speed of response, Measuring lag, Fidelity, Dynamic error of measuring instruments - Absolute, gross, systematic, random and limiting errors in measurements -Statistical estimation of measurements data: Arithmetic mean, Average deviation, Standard deviation, Variance and Probable error of mean - Standards and calibration.

UNIT II ELECTRICAL MEASURING INSTRUMENTS 9

Classification of measuring instruments-Essential requirements of an instrument-Construction, working principle and Torque equation of Permanent Magnet Moving Coil instruments - Attraction type and Repulsion type Moving iron instruments-Electro-dynamometer type Wattmeter, Extension of Voltmeter and Ammeter range -Construction, working principle of Instrument transformers-1φ Induction type Energy meter.

UNIT III MEASUREMENT OF RESISTANCE, INDUCTANCE & CAPACITANCE 9

D.C Bridges: Wheatstone Bridge, Kelvin's bridge, Kelvin's double bridge - A.C bridges: Maxwell's bridge, Anderson bridge, Hays bridge, Schering bridge, Wein's bridge.

UNIT IV MAGNETIC MEASUREMENTS & ELECTRONIC INSTRUMENTS 9

Magnetic Measurements: Measurement of Flux density and Magnetizing force, Determination of B-H curve for the magnetic material specimen, Measurement of Iron-loss using Maxwell's bridge method-Weston frequency meter – Multimeter-Servo- potentiometer type, Successive approximations type Digital Voltmeter - Construction, working principle and applications of X –Y recorder, PC based data acquisition system.

UNIT V MEASUREMENT OF NON-ELECTRICAL QUANTITIES 9

Transducers: Classifications and Selection of transducers –Principle of operation of Resistance Potentiometer-Strain gauge transducers - Capacitive transducers-Linear Variable Differential Transducer, Piezo-electric transducers - Measurement of Temperature: Resistance thermometers, Thermistors and Thermocouples-Speed measurement: Contact and non-contact type.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students would be able to

CO1: Calibrate electrical parameter measuring instruments.
CO2: Apply analog and digital techniques to measure electrical quantities.
CO3: Measure resistance, inductance and capacitance using various bridge circuits.
CO4: Measure Magnetic parameters and use various Electronics Instruments.
CO5: Use various transducers for measuring non-electrical quantities.
CO6: Identify various errors during measurement.

TEXT BOOKS:

1. Sawhney A K, "A Course in Electrical and Electronic Measurement and Instrumentation", Dhanpat Rai & Sons, New Delhi, 2022.
2. Doeblin E O and Dhanesh N Manik, ―Measurement Systems", McGraw-Hill, New Delhi, 2019.

REFERENCE BOOKS:

1. Gupta J.B., "A Course in Electronic and Electrical Measurements", S. K. Kataria& Sons, Delhi, 2024.
2. PrithwirajPurkait, Budhaditya Biswas, ChiranjibKoley "Electrical and Electronics Measurements and Instrumentation", McGraw Hill Education India, First Edition, 2013.
3. Golding E W, and Widdis F C, "Electrical Measurements and Measuring Instruments", A H Wheeler &Company, Calcutta, Fifth Edition, 2011.
4. Moorthy D.V.S, "Transducers and Instrumentation", Prentice Hall of India Pvt.Ltd, 2012..
5. Patranabi.D, "Sensors and Transducers", PHI Learning Pvt. Ltd., 2003.
6. Kalsi H.S, "Electronic Instrumentation", McGraw Hill Education India, 3rd Edition, 2010.
7. Rangan C S, Sharma G R, Mani V S, ‗Instrumentation Devices and Systems', Tata McGraw-Hill, New Delhi, 2017.

U23EET32	DIGITAL LOGIC CIRCUITS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To study various number systems, simplify the logical expressions using Boolean functions
2. To study implementation of combinational circuits
3. To design various synchronous circuits.
4. To introduce asynchronous sequential circuits and PLCs.
5. To design asynchronous sequential circuits

UNIT I NUMBER SYSTEMS AND DIGITAL LOGIC FAMILIES 9

Review of number systems, binary codes, error detection and correction codes. Digital Logic Families – Introduction to RTL, DTL, TTL, ECL and MOS families – wired and operation, characteristics of digital logic family – Comparison of digital logic families.

UNIT II COMBINATIONAL LOGIC 9

Combinational logic - representation of logic functions-SOP and POS forms, K-map representations- minimization using K maps - simplification and implementation of combinational logic - multiplexers and demultiplexers – decoders, encoders - code converters, adders, subtractors.

UNIT III SEQUENTIAL LOGIC 9

Sequential logic- SR, JK, D and T flip flops - level triggering and edge triggering - counters – Pulse forming circuits - asynchronous and synchronous type - Modulo counters - Shift registers – Ring counters.

UNIT IV SYNCHRONOUS SEQUENTIAL LOGIC 9

Synchronous sequential logic circuits – state table and excitation tables – state diagrams – Moore model and Melay models – design of counters – analysis of synchronous sequential logic circuits – state reduction and state assignment.

UNITV ASYNCHRONOUS SEQUENTIAL LOGIC 9

Asynchronous sequential logic circuits – Transition table – flow table – race conditions – circuits with latches, analysis of asynchronous sequential logic circuits – introduction to design – implication table – hazards – programmable logic array and devices.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students would be able to

CO1:	Interpret, convert and represent different number systems.
CO2:	Manipulate and examine Boolean algebra, logic operations, Boolean functions and their simplification.
CO3:	Design and analyze combinational and sequential logic circuits
CO4:	Design synchronous sequential logic circuits
CO5:	Analyze combinational and sequential circuits
CO6:	Design asynchronous sequential logic circuits

TEXT BOOKS:

1. Thomas L Floyd, 'Digital fundamentals', Pearson Education Limited, 11th Edition, 2015.
2. M. Morris Mano, 'Digital Design with an introduction to the VHDL', Pearson Education,2018.
3. Donald D. Givone, 'Digital Principles and Design', Tata McGraw Hill, 1st Edition, 2017.

REFERENCE BOOKS:

1. Tocci R.J., Neal S. Widmer, 'Digital Systems: Principles and Applications', Pearson Education Asia, 2014.
2. Donald P Leach, Albert Paul Malvino, Goutam Sha, 'Digital Principles and Applications', Tata McGraw Hill, 7th Edition, 2010.
3. William Keitz, Digital Electronics-A Practical Approach with VHDL, Pearson,2013.
4. Floyd and Jain, 'Digital Fundamentals', 8th edition, Pearson Education, 2020.
5. Anand Kumar, Fundamentals of Digital Circuits, PHI,2016.
6. Charles H.Roth,Jr,Lizy Lizy Kurian John, 'Digital System Design using VHDL, Cengage, 2013.
7. John M.Yarbrough, 'Digital Logic, Application & Design', Thomson, 2002.
8. Gaganpreet Kaur, VHDL Basics to Programming, Pearson, 2013.
9. Botros, HDL Programming Fundamental, VHDL& Verilog, Cengage, 2013.
10. A.P.Godse, Digital Logic Circuits, Technical Publications, 2022.

U23EET33	ELECTRIC AND MAGNETIC FIELDS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. The basic mathematical concepts related to electromagnetic vector fields.
2. Concepts of electrostatics, and electrical potential.
3. Concepts of magneto statics, magnetic flux density, scalar and vector potential and their calculations.
4. Faraday's laws, induced emf and their applications.
5. Design asynchronous sequential logic circuits

UNIT I VECTOR ANALYSIS 09

Vector fields – Different co-ordinate systems – Rectangular, Cylindrical, Spherical co-ordinate systems – Gradient, Divergence and Curl – Divergence Theorem – Stoke's Theorem.

UNIT II ELECTROSTATICS- I 09

Sources and effects of electromagnetic fields – Coulomb's Law – Electric field intensity – Field due to point and continuous charges –Gauss's law and applications – Electric potential – Energy density.

UNIT III ELECTROSTATICS- II 09

Electric field in free space, conductors, dielectric - Dielectric polarization - Dielectric strength - Electric field in multiple dielectrics – Boundary conditions– Poisson's and Laplace's equations – Capacitance.

UNIT IV MAGNETOSTATICS 09

Magnetic field intensity – Biot-Savart Law - Ampere's Law and applications - Magnetic field due to straight conductors, circular loop, infinite sheet of current – Magnetic flux density (B) – Magnetization –Boundary conditions – Scalar and vector potential –Inductance – Energy density.

UNITV ELECTRODYNAMIC FIELDS 09

Magnetic force – Lorentz Law of force –Torque –Faraday's laws, induced emf – Transformer and motional EMF –Maxwell's equations (differential and integral forms) –Displacement current – Derivation of generalized Wave Equations from Maxwell's equations.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Apply the basic mathematical concepts related to electromagnetic vector fields in field calculations.

CO2: Apply the basic concepts about electrostatic fields for the calculation of electric field intensity, electrical potential and energy density.

CO3: Explain Electric field in free space, conductors, dielectric and multiple dielectrics and apply the basic concepts in Capacitance calculations.

CO4: Apply the basic concepts about magneto static fields for the calculation of magnetic flux density and scalar potential.

CO5: Explain the different methods of emf generation and Maxwell's equations.

CO6: Design asynchronous sequential logic circuits.

TEXT BOOKS:

1. Mathew N. O. SADIKU, "Elements of Electro magnetics", Oxford University Press Inc., Seventh Edition, 2018.
2. William H.Hayt, "Engineering Electro magnetics", McGraw Hill, Sixth Edition, 2018.

REFERENCE BOOKS:

1. Joseph. A.Edminister, "Theory and Problems of Electromagnetics", Second Edition, Schaum Series, McGraw Hill, 2017.
2. Kraus and Fleish, "Electromagnetics with Applications", McGraw Hill International Editions, Fifth Edition, 2017.
3. AshutoshPramanik, "Electromagnetism – Theory and Applications", Prentice-Hall of India Private Limited, New Delhi, Second Edition 2009.
4. Gangadhar K.A., "Field Theory", Khanna Publishers, Fifteenth Edition, Third Reprint 2015.

U23EET34	ELECTRONIC DEVICES AND CIRCUITS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Construction, Theory, Characteristics and Applications of Electronic Devices, Power supplies.
2. Operation of Amplifiers and Oscillators.
3. Construction and operation of regulator and filter circuits.
4. Working of Field controlled device
5. Construction and working of Special diodes

UNIT I PN JUNCTION AND SPECIAL DIODES 9

PN junction diode-Operation, VI characteristics –static and dynamic resistance - Diode current equation: Drift and diffusion currents – temperature effects - Diode equivalent circuits – diode junction capacitances - switching characteristics –Zener diode – VI characteristics, LED.

UNIT II RECTIFIERS, FILTERS AND REGULATORS 9

Diode clampers and clippers – Rectifiers: Half wave and full wave rectifiers, Average and RMS value, Ripple factor, Regulation, Rectification efficiency, Filters: C, L, LC filters – Zener diode shunt Regulator.

UNIT III BJT AND ITS BIASING 9

Transistor construction, operation – Input and output characteristics – CE, CB and CC configurations – hybrid model – transistor switching – transistor biasing: operating point, load line and stability factor – base bias and voltage divider bias - Darlington connection - Phototransistor and Opto couplers.

UNIT IV FIELD CONTROLLED DEVICES 9

JFET – construction, operation and characteristics, parameters, pinch-off voltage – small signal frequency model - MOSFET - construction, operation and characteristics – enhancement and depletion types – parameters – MOSFET as voltage variable resistor. UJT – characteristics, operation and saw tooth oscillators.

UNITV FEEDBACK AMPLIFIERS & OSCILLATORS 9

Feedback amplifiers: Feedback concepts - Advantages and Disadvantages of negative feedback – Feedback connections - Voltage / current, series / shunt feedback - Oscillators - condition for oscillation – Hartley, Colpitts, RC phase shift, Wien bridge and crystal oscillator.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Demonstrate the construction, theory and characteristics of the basic electronic devices.
CO2: Design a power supply, regulator and filter.
CO3: Demonstrate the construction, operation and characteristics of BJT.
CO4: Demonstrate the construction, operation and characteristics of FET devices .
CO5: Identify and design a suitable amplifier/oscillator for a specific application.
CO6: Explain concepts of special diodes

TEXT BOOKS:

1. Robert L. Boylestad, Louis Nashelsky "Electronic Devices and Circuit Theory", Eleventh Edition, Prentice Hall of India, 2013
2. R.S.Sedha, "A Textbook of Electronic Devices and Circuits", S. Chand & company Ltd. 2007.

REFERENCE BOOKS:

1. Albert Paul Malvino, "Electronic Principles", Tata McGraw Hill, 2002.
2. David A. Bell, "Electronic Devices and Circuits", 5th Edition, Prentice Hall India, 2008.
3. Millman and Halkias, "Electron devices and circuits", Tata McGraw Hill, New Delhi, 4th edition, 2011.

U23EET35	DC MACHINES AND TRANSFORMERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Principles of electromechanical energy conversion in singly excited systems.
2. Working principles of DC Generators, Types, characteristics, starting and speed control
3. Working principles of DC Generators, Types, characteristics, starting and speed control.
4. Estimation of various losses in D.C. machines by conducting different tests.
5. Principle of operation, prediction of performance, the methods of testing the transformers and three phase transformer connections.

UNIT I ELECTROMECHANICAL ENERGY CONVERSION 9

Principle of Energy conversion – Review of magnetic circuit–Faraday's law of induced EMF - Hysteresis and Eddy Current losses – AC operation of magnetic circuits - Singly and Doubly Excited magnetic field systems – Torque production in rotating machines.

UNIT II DC GENERATORS 9

Constructional features of a DC machine – Principle of Operation of DC generator – EMF equation – Methods of Excitation – Types of generator – No load and Load characteristics of DC generators – Commutation – Armature Reaction and its effects – Parallel operation of DC shunt generators – Applications.

UNIT III DC MOTORS

9

Principle of operation – Back EMF & Torque equation – Characteristics of series, shunt & compound motors –starting of DC motors– Types of starters– Speed control methods for DC shunt & series motors – Applications.

UNIT IV TRANSFORMERS 9

Construction – Principle of Operation – EMF Equation –Transformer on no load and load – Phasor diagram –Equivalent Circuit –Auto Transformer –Tap Changing – Parallel operation of single phase transformers – Three phase transformer Connections – Scott Connection – Parallel operation of three phase transformers.

UNITV TESTING OF DC MACHINES AND TRANSFROMERS 9

Testing of DC machines – Brake test, Swinburne's test& Hopkinson's test. Losses & efficiency – Condition for maximum efficiency. Testing of Transformer: Polarity test, Open Circuit and short circuit tests & Sumpner's test – Losses, Efficiency and Voltage Regulation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1:** Describe Energy Conversion of Electro Mechanical Devices.
- **CO2:** Select DC Generator for a particular application based on its Characteristics.
- **CO3:** Select DC Motor for a particular application based on its Characteristics.
- **CO4:** Estimate Transformer parameters and its performance.
- **CO5:** Estimate machine parameters by conducting various tests.
- **CO6:** Construction and working of Special diodes

TEXT BOOKS:

1. Nagrath, I.J.and Kothari, D.P.", "Electrical Machines", McGraw Hill Publishing Company Ltd., New Delhi, Reprint 2017.
2. Theraja A.K &Theraja B.L, "A Text book of Electrical Technology (Vol II)", S Chand & Co., 23rd Edition 2014.

REFERENCE BOOKS:

1. Rajput, R.K, "Electrical Machines", Laxmi publications, New Delhi 5th Edition, 2008.
2. Parkar Smith, N.N., "Problems in Electrical Engineering" CBS Publishers and Distributers, New Delhi, 9th Edition, 2017.
3. Say.M.G. "Alternating Current Machines", ELBS & Pitman, London, 5th Edition,2018.

U23EEP31	ELECTRONIC DEVICES AND CIRCUITS LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. The behaviour of semiconductor device based on experimentation.
2. Design of filters.
3. Characteristics of BJT and JFET
4. Design of various rectifiers
5. Simulation of oscillators

LIST OF EXPERIMENTS

1. Realization of Passive Low Pass Filter and High Pass Filter
2. Characteristics of Semiconductor Diode and Zener Diode
3. Characteristics of Photo diode and Phototransistor
4. Diode clipper circuits and Clamper circuits
5. Single Phase Half wave rectifier with Capacitive and Inductive - Capacitive Filter
6. Single Phase Full wave rectifiers with Capacitive and Inductive - Capacitive Filter
7. Bipolar Junction Transistor - CE characteristics
8. Bipolar Junction transistor - CB characteristics
9. Characteristics of JFET
10. Frequency Response of Common Emitter Amplifier
11. Characteristics of UJT
12. Transistor Astable Multivibrator
13. Simulation of RC Phase Shift Oscillator

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl. No.	Name of the Equipment	Quantity
1.	Semiconductor devices like Diode, Zener Diode,NPN Transistors, JFET, UJT, Photo diode, Photo Transistor	
2.	Resistors, Capacitors and inductors	
3.	Necessary digital IC	8
4.	Function Generators	10
5.	Regulated 3 output Power Supply 5, ± 15V	10
6.	CRO	10
7.	Storage Oscilloscope	1
8.	Bread boards	
9.	Atleast one demo module each for the listed equipments.	
10.	Component data sheets to be provided	

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Identify and select a suitable semiconductor device for a specific applications based on the characteristic
CO2:	Design and choose a suitable filter for various applications based on its filtering action.
CO3:	Design an amplifier using BJT
CO4:	Design a wave shaping circuit.
CO5:	Design an amplifier using JFET
CO6:	Design half wave and full wave rectifiers

U23EEP32	DC MACHINES AND TRANSFORMERS LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To make the students to know about the operation, performance and Characteristics of D.C. machines and transformers by conducting various tests
2. To enable the students to be familiar with the speed control of DC Motors
3. To understand the working of DC motor starters
4. To understand the working of single phase and three phase transformer
5. Concepts of transformer testing

LIST OF EXPERIMENTS

1. Load test on single-phase transformer and three phase transformer connections
2. Open circuit and load characteristics of separately excited DC Generator.
3. Open circuit and load characteristics of self-excited DC shunt Generator
4. Load characteristics of DC compound generator with differential and cumulative connection
5. Load characteristics of DC shunt and compound motor
6. Load characteristics of DC series motor
7. Swinburne's test and speed control of DC
8. Hopkinson's test on DC motor – generator set Open & short circuit test and polarity tests on single phase transformer.
9. Sumpner's test on transformers
10. Separation of no-load losses in single phase transformer
11. Study of D.C motor starters

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	DC Shunt Motor with Loading Arrangement	3
2.	DC Shunt Motor Coupled with Three phase Alternator	1
3.	Single Phase Transformer	4
4.	DC Series Motor with Loading Arrangement	1
5.	DC compound Motor with loading Arrangement	1
6.	Three phase Induction motor with loading Arrangement	2
7.	Single phase induction motor with loading arrangement	1
8.	DC Shunt Motor coupled with DC compound Generator	2
9.	DC Shunt motor coupled with DC Shunt Motor	1
10.	Tachometer -Digital/Analog	8
11.	Single Phase Auto Transformer	2
12.	Three Phase Auto Transformer	1
13.	Single phase Resistive loading bank	2
14.	Three phase Resistive loading bank	2

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Determine the performance characteristics of DC machines for different operating conditions
CO2:	Determine the performance characteristics and parameters of Transformers under different operating conditions
CO3:	Separate no load losses of Transformers
CO4:	Understand the performance characteristics of DC generator
CO5:	Understand the testing of single phase and three phase transformer
CO6:	Explain various D.C motor starters

SEMESTER IV

U23EET41	INDUCTION AND SYNCHRONOUS MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Operation of AC generators and motors (Both three phase and single phase)
2. Methods for determining regulation of AC generator
3. Predetermination of parameters of three phase induction motor.
4. Starters and speed control methods of three phase induction motor.
5. Operation of single phase induction motor and special machines

UNIT I SYNCHRONOUS GENERATOR 9

Constructional details – Types of rotors – EMF equation – Synchronous reactance – Armature reaction – Voltage regulation – EMF, MMF, ZPF and ASA methods – Synchronizing and parallel operation – Synchronizing torque - Operating characteristics - Capability curves– Salient pole Machine: Two reaction theory – Determination of direct and quadrature axis synchronous reactance using slip test – Expression for power developed

UNIT II SYNCHRONOUS MOTOR 9

Principle of operation – procedure for starting - Starting methods – Different torques - V& inverted V curves – Power input and power developed equations — Current loci for constant power input, constant excitation and constant power developed – Hunting – natural frequency of oscillations – Experimental method of obtaining V and inverted V curves - Applications

UNIT III THREE PHASE INDUCTION MACHINES 9

Constructional details – Types of rotors – Principle of operation – Slip – Equivalent circuit – Slip-torque characteristics - Condition for maximum torque – Losses and efficiency – Load test - No load and blocked rotor tests - Circle diagram – Separation of no load losses – Cogging – Crawling - Double cage rotors – Induction generator – Synchronous induction motor

UNIT IV STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR 9

Need for starters – Types of starters: Primary resistor, Autotransformer and Star-delta starters and Rotor resistance starter – Speed control: Change of voltage, frequency, number of poles and V/f control – Cascaded connection – Slip power recovery scheme

UNITV SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES 9

Constructional details of single phase induction motor – Double field revolving theory and operation – Equivalent circuit — Starting methods of single-phase induction motors - Shaded pole induction motor - Linear induction motor - Reluctance motor – Hysteresis motor – Universal motor

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students would be able to

CO1: Determine regulation of both types of alternators

CO2: Start synchronous motor and recommend for various specific applications

CO3: Distinguish between types of Induction motors and select correctly the drive for applications

CO4: Differentiate between different types of starting and speed control methods

CO5: Select proper single phase motors for specific application requirements

CO6: Describe the construction, principle of operation of special machines

TEXT BOOKS:

1. Kothari D.P and Nagrath I.L., "Electric Machines", McGraw Hill Publishing Company Ltd , Fourth Edition,2018.
2. Bhimbhra P.S., "Electrical Machinery", Khanna Publishers, 2011.
3. Theraja B.L., " A Text of Electrical Technology, Volume-II", S.Chand & Co Ltd, 2024.

REFERENCE BOOKS:

1. Fitzgerald A.E., Charles Kingsley, Stephen.D.Umans, "Electric Machinery", McGraw Hill Publishing Company Ltd., 2003.
2. Gupta J.B., "Theory and Performance of Electrical Machines", S.K.Kataria and Sons, 2015.
3. Cotton H. "Advanced Electrical Technology " Pitman, London, 2005.
4. Say M.G., "Alternating current Machines", ELBS & Pitma,2018.

U23GET41	ENVIRONMENTAL SCIENCES AND ENGINEERING	L	T	P	C
		3	0	0	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Studying the nature and the facts about environment.
2. Finding and implementing scientific, technological, economic and political solutions to environmental problems
3. Studying the interrelationship between living organism and environment.
4. Appreciating the importance of environment by assessing its impact on the human world envisions the surrounding environment, its functions and its value.
5. Studying the dynamic processes and understand the features of the earth's interior and surface.
6. Studying the integrated themes and biodiversity, natural resources, pollution control and waste Management.

UNIT I ECOSYSTEM AND BIODIVERSITY 9

Definition, Scope and importance of environment – Need for public awareness. Eco-system- Types and Energy flow– Ecological succession. Types of biodiversity: genetic, species and ecosystem diversity – values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

UNIT II ENVIRONMENTAL POLLUTION 9

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts.

UNIT III RENEWABLE SOURCES OF ENERGY 9

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT IV ENVIRONMENTAL ISSUES 9

Social Issues and possible solutions – climate change, global warming, acid rain,ozone layer depletion, nuclear accidents and holocaust - Population growth, variation among nations population explosion – family welfare programme – human rights – value education – HIV / AIDS – women and child welfare.

UNITV SUSTAINABILITY PRACTICES 9

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment,Environmental Impact Assessment. Sustainable habitat:Development,GDP,Sustainability- Green buildings, Green materials, Energyefficiency, Sustainable transports.Sustainable energy Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio economic andtechnologicalchange.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end ofthe course the students would be able to

CO1:	Explain Environmental Pollution or problems cannot be solved by mere laws.
CO2:	Illustrate Public participation is an important aspect which serves the environmental Protection.
CO3:	Obtain knowledge after completing the course.
CO4:	Explain Public awareness of environmental is at infant stage.
CO5:	Ignorance and incomplete knowledge has lead to misconceptions
CO6:	Development and improvement in std. of living has lead to serious environmental disasters

TEXT BOOKS:

1. BennyJoseph,'Environmental Science and Engineering',TataMcGraw-Hill,NewDelhi,2016.
2. GilbertM.Masters,'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
3. Allen,D.T.andShonnard,D.R.,Sustainability Engineering: Concepts, Design and Case Studies, PrenticeHall.
4. Dr.J. Manivel and Dr.A. Arunkumar, "Environmental Science & Engineering" R.K.Publishers, 1st Edition 2023

REFERENCE BOOKS:

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
4. Erach Bharuch "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013

U23EET42	TRANSMISSION AND DISTRIBUTION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Computation of transmission line parameters.
2. Equivalent circuits for the transmission lines based on distance and operating voltage fordetermining voltage regulation and efficiency.
3. Improving the voltage profile of the transmission system.
4. Voltage distribution in insulator strings and Grading of cables
5. Types of Distribution System

UNIT I TRANSMISSION LINE PARAMETERS **9**

Resistance, inductance and capacitance calculations: single and three phase transmission lines - double circuits - solid, stranded and bundled conductors - symmetrical and unsymmetrical spacing – transposition of lines - concepts of GMR and GMD - skin and proximity effects

UNIT II MODELLING AND PERFORMANCE OF TRANSMISSION LINES **9**

Transmission line classification - short line, medium line and long line – equivalent circuits – Sending end voltage, current, voltage regulation and transmission efficiency- ABCD constants- real and reactive power flow in lines – surge impedance and surge-impedance loading - Ferranti effect - Corona discharge characteristics – critical voltage and corona loss.

UNIT III STRUCTURE OF POWER SYSTEM **9**

Structure of electric power system - operating voltages of generation, transmission and distribution – advantage of higher operating voltage for AC transmission - Right of Way. Substation layout. Mechanical designs of transmission line: Sag and tension calculations- effect of ice and wind on sag.

UNIT IV INSULATORS AND UG CABLES **9**

Insulators: Types - Characteristics and classification – voltage distribution in insulator string - improvement of string efficiency. Underground cables: constructional features of LT and HT cables – insulation resistance, capacitance, and dielectric stress – grading of UG cables.

UNIT V DISTRIBUTION SYSTEM **9**

Feeders, distributors and service mains. DC 2-wire distributor – radial and ring main distribution. AC distribution – single phase (with concentrated loads) and three phase 3-wire and 4-wire distribution with balanced and unbalanced loads.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students would be able to

CO1: Calculate the sag of transmission lines.
CO2: Estimate the line parameters for transmission lines.
CO3: Model the distribution system
CO4: Predict the performance parameters of transmission lines
CO5: Explain voltage distribution in insulator strings and Grading of cables
CO6: Explain the types of Distribution System

TEXT BOOKS:

1. Gupta B.R., “Power System Analysis and Design”, S. Chand, New Delhi, 2011.
2. Soni M L, Gupta P V, Bhatnagar U S and Chakrabarthi A, "A Text Book on Power System Engineering", Dhanpat Rai & Co., New Delhi, 2009.
3. Kothari D P and Nagrath J, “Power System Engineering”, McGraw-Hill Publishing Company New Delhi, Third Edition 2019.

REFERENCE BOOKS:

1. Uppal S L, "Electrical Power", Khanna Publishers, New Delhi, Thirteenth Edition, 2003.
2. Wadhwa C L, "Electrical Power Systems", New Age International Publishers, Delhi, 2006 Fourth Edition Reprint Aug, 2007.
3. Mehta V K, Rohit Mehta , "Principles of Power Systems", S.Chand & Co. Pvt. Ltd., New Delhi, 2005.
4. Gupta J B, “A Course in Electrical Power”, S. K. Kataria & Sons, 2009
5. Singh S.N., “Electric Power Generation, Transmission and Distribution”, Prentice Hall of India Pvt. Ltd, New Delhi, 2002.

U23CST35 C PROGRAMMING AND DATA STRUCTURES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To introduce the basics of C programming language.
2. To learn the concepts of advanced features of C.
3. To understand the concepts of ADTs and linear data structures.
4. To know the concepts of non-linear data structure and hashing.
5. To familiarize the concepts of sorting and searching techniques.

UNIT I C PROGRAMMING FUNDAMENTALS 9

Data Types – Variables – Operations – Expressions and Statements – Conditional Statements – Functions – Recursive Functions – Arrays – Single and Multi-Dimensional Arrays.

UNIT II C PROGRAMMING - ADVANCED FEATURES 9

Structures – Union – Enumerated Data Types – Pointers: Pointers to Variables, Arrays and Functions – File Handling – Preprocessor Directives.

UNIT III LINEAR DATA STRUCTURES 9

Abstract Data Types (ADTs) – List ADT – Array-Based Implementation – Linked List – Doubly-Linked Lists – Circular Linked List – Stack ADT – Implementation of Stack – Applications – Queue ADT – Priority Queues – Queue Implementation – Applications.

UNIT IV NON-LINEAR DATA STRUCTURES 9

Trees – Binary Trees – Tree Traversals – Expression Trees – Binary Search Tree – Hashing - Hash Functions – Separate Chaining – Open Addressing – Linear Probing– Quadratic Probing – Double Hashing – Rehashing.

UNITV SORTING AND SEARCHING TECHNIQUES 9

Insertion Sort – Quick Sort – Heap Sort – Merge Sort –Linear Search – Binary Search.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Develop C programs for any real world/technical application.

CO2 : Apply advanced features of C in solving problems.

CO3: Write functions to implement linear and non–linear data structure operations.

CO4: Suggest and use appropriate linear/non–linear data structure operations for solving a given problem.

CO5: Appropriately use sort and search algorithms for a given application.

CO6: Apply appropriate hash functions that result in a collision free scenario for data storage and retrieval.

TEXT BOOKS:

1. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, Second Edition, Pearson Education, 2014.
2. ReemaThareja, “Programming in C”, Second Edition, Oxford University Press, 2016.

REFERENCE BOOKS:

1. Brian W. Kernighan, Rob Pike, “The Practice of Programming”, Pearson Education, 1999.
2. Paul J. Deitel, Harvey Deitel, “C How to Program”, Seventh Edition, Pearson Education, 2013.
3. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, “Data Structures and Algorithms”, Pearson Education,1983.
4. Ellis Horowitz, SartajSahni and Susan Anderson, “Fundamentals of Data Structures”, Galgotia, 2008.

U23EET43	LINEAR INTEGRATED CIRCUITS AND APPLICATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Discussing the basic building blocks of linear integrated circuits,
2. Analysing Signal using Op-amp based circuits its characteristics and their configurations.
3. Outline the design procedure of applications using operational amplifiers, analog multipliers and PLL.
4. Understanding the operation of ADC and DAC.
5. Introducing the concepts of waveform generation and introduce some special function ICs

UNIT I CHARACTERISTICS OF OPAMP 9

Classification ofIntegratedCircuits-IdealOP-AMP characteristics,DCcharacteristics,AC characteristics, offset voltage and current - Compensation, Inverting and non-inverting Amplifiers.

UNIT II APPLICATIONS OF OPAMP 9

Summer, differentiator and integrator - Voltage comparators - Instrumentation amplifier, V/I & I/V converters, clippers, clampers, peak detector, S/H circuit, D/A converter (R-2R ladder and weighted resistor types), A/D converter - Dual slope, successive approximation and flash types.

UNIT III DESIGN WITH OPAMP 9

First and second order active filters - Oscillators - Waveform generator - Schmitt trigger-multivibrators.

UNIT IV SPECIAL ICs 9

555 Timer circuit - Functional block, characteristics & applications; 566-voltagecontrolledoscillator circuit; 565-phase lock loop circuit functioning and applications, Analog multiplier ICs.

UNITV APPLICATION OF ICs 9

Voltage regulators - IC 7805 - IC 723 - Switched capacitor filters - switching regulator, MA 7840, LM 380 power amplifier, ICL 8038 function generator IC, isolation amplifiers, opto coupler, opto electronic ICs.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students would be able to

CO1: Describe the fabrication methods of op-amp.
CO2: Describe the characteristics of op-amp.
CO3: Design different applications using general purpose op- amp and application specific ICs
CO4: Design circuits using Multipliers, and PLL
CO5: Describe applications using Timer IC.
CO6: Describe the application of ICs

TEXT BOOKS:

1. David A. Bell, ‘Op-amp & Linear ICs’, Oxford, 2013.
2. D. Roy Choudhary, Sheil B. Jani, ‘Linear Integrated Circuits’, Sixth edition, New Age, 2021.
3. Ramakant A.Gayakward, ‘Op-amps and Linear Integrated Circuits’, IV edition, Pearson Education, 2016.

REFERENCE BOOKS:

1. Fiore,"Opamps & Linear Integrated Circuits Concepts & applications", Cengage, 2010.
2. Floyd ,Buchla,"Fundamentals of Analog Circuits, Pearson, 2013.
3. Jacob Millman, Christos C.Halkias, 'Integrated Electronics - Analog and Digital circuits system', McGraw Hill, 2017.
4. Robert F.Coughlin, Fredrick F. Driscoll, 'Op-amp and Linear ICs', Pearson, 6th edition,2015.
5. Sergio Franco, 'Design with Operational Amplifiers and Analog Integrated Circuits', Mc Graw Hill, 2016.
6. Muhammad H. Rashid,' Microelectronic Circuits Analysis and Design' Cengage Learning, 2011.

U23EET44	ANALOG AND DIGITAL COMMUNICATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Introducing the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues.
2. Studying the various analog and digital modulation techniques
3. Studying the principles behind information theory and coding
4. Studying the various digital communication techniques
5. Studying the Spread Spectrum and Multiple Access

UNIT I ANALOG MODULATION 9

Amplitude Modulation – AM, DSBSC, SSBSC, VSB – PSD, modulators and demodulators – Angle modulation – PM and FM – PSD, modulators and demodulators – Superheterodyne receivers

UNIT II PULSE MODULATION 9

Low pass sampling theorem – Quantization – PAM – Line coding – PCM, DPCM, DM, and ADPCM And ADM, Channel decoder - Time Division Multiplexing, Frequency Division Multiplexing

UNIT III DIGITAL MODULATION & TRANSMISSION 9

Phase shift keying – BPSK, DPSK, QPSK – Principles of M-ary signaling M-ary PSK & QAM – Comparison, ISI – Pulse shaping – Duo binary encoding – Cosine filters – Eye pattern, equalizers

UNIT IV INFORMATION THEORY & CODING 9

Measure of information – Entropy – Source coding theorem – Shannon–Fano coding, Huffman Coding, LZ Coding – Channel capacity – Shannon-Hartley law – Shannon's limit – Error control codes – Cyclic codes, Syndrome calculation – Convolution Coding, Sequential and Viterbi decoding

UNITV SPREAD SPECTRUM AND MULTIPLE ACCESS 9

PN sequences – properties – m-sequence – DSSS – Processing gain, Jamming – FHSS – Synchronisation and tracking – Multiple Access – FDMA, TDMA, CDMA

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students would be able to

CO1:	Comprehend and appreciate the significance and role of this course in the present contemporary world
CO2:	Apply analog and digital communication techniques.
CO3:	Use data and pulse communication techniques.
CO4:	Apply Digital and Pulse Modulation techniques
CO5:	Analyze Source and Error control coding.
CO6:	Analyze different Multiple access methods

TEXT BOOKS:

1. H Taub, D L Schilling, G Saha, ―Principles of Communication Systems, TMH Fouth edition 2017.
2. S. Haykin ―Digital Communications‖ John Wiley 2013.

REFERENCE BOOKS:

1. B.P.Lathi, ―Modern Digital and Analog Communication Systems, 3rd edition, Oxford University Press, 2017
2. H P Hsu, Schaum Outline Series – ―Analog and Digital Communications, TMH 2017.
3. B.Sklar, Digital Communications Fundamentals and Applications, 2/e, Pearson Education 2021.

U23EEP41	INDUCTION AND SYNCHRONOUS MACHINES LABORATORY	L	T	P	C
		0	0	3	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To acquire practical knowledge in determining regulation of synchronous machines
2. To understand and analyze performance characteristics of synchronous & induction machines
3. To predetermine the performance characteristics of induction machine
4. To understand the speed control methods of BLDC Motor
5. To analyse the separation of No-load losses of three-phase induction motor

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. Load test on Alternator (with resistive, inductive and capacitive loads)
5. Speed control of BLDC Motor
6. V and Inverted V curves of Three Phase Synchronous Motor
7. Load test on three-phase squirrel cage induction motor
8. Load test on three-phase slip ring induction motor
9. Predetermination of performance characteristics of three-phase induction motor by circle diagram and equivalent circuit.
10. Separation of No-load losses of three-phase induction motor
11. Load test on single-phase induction motor
12. Equivalent circuit of single-phase induction motor.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Synchronous Induction motor 3HP	**1**
2.	DC shunt motor coupled with three phase alternator	**4**
3.	DC shunt motor coupled with three phase slip ring induction motor	**1**
4.	Three phase induction motor with loading arrangement	**2**
5.	Single phase induction motor with loading arrangement	**2**
6.	Tachomenter – Digital/Analog	**8**
7.	Single phase Auto Transformer	**2**
8.	Three phase Auto transformer	**3**
9.	Single phase resistive loading bank	**2**
10.	Three phase resistive loading bank	**2**
11.	Capacitor bank	**2**

COURSE OUTCOMES:

At the end ofthe course thestudentswouldbeableto

CO1:	Perform load test on generators & motors and to obtain performance characteristics.
CO2:	Perform load test on motors and to obtain performance characteristics.
CO3:	Apply various methods and techniques to determine regulation of alternators.
CO4:	Predetermine the performance characteristics of induction machines
CO5:	Determine the No-load losses of Induction Motor
CO6:	Apply the speed control techniques of BLDC Motor

U23EEP42	LINEAR AND DIGITAL CIRCUITS LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Design, testing and characterizing of circuit behavior with combinational logic gate ICs.
2. Design, testing and characterizing of circuit behavior with register/ counter and sequential logic ICs.
3. Design, testing and characterizing of circuit behavior with OPAMP ICs.
4. Design, testing and characterizing of circuit behavior with analog Ics like 555 timer VCO and regulators.
5. Design, testing and characterizing of circuit behavior with digital Ics like decoders, multiplexers.

LIST OF EXPERIMENTS

1. Implementation of Boolean Functions, Adder/ Subtractor circuits.
2. Code converters: Excess-3 to BCD and Binary to Gray code converter and vice-versa
3. Parity generator and parity checking
4. Encoders and Decoders
5. Counters: Design and implementation of 4-bit modulo counters as synchronous and Asynchronous types using FF IC's and specific counter IC.
6. Shift Registers: Design and implementation of 4-bit shift registers in SISO, SIPO, PISO, PIPO modes using suitable IC's.
7. Study of multiplexer and demultiplexer
8. Timer IC application: Study of NE/SE 555 timer in Astable, Monostable operation.
9. Application of Op-Amp: inverting and non-inverting amplifier, Adder, comparator, Integrator and Differentiator.
10. Study of VCO and PLL ICs: Voltage to frequency characteristics of NE/ SE 566 IC. Frequency multiplication using NE/SE 565 PLL IC.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Dual (0-30V) variability power supply	10
2.	CRO 30MHz	9
3.	Digital Multimeter	10
4.	Function Generator 1MHz	8
5.	IC Tester (Analog)	2
6.	Bread board	10
7.	Computer (PSPICE installed)	1
8.	IC 741/IC NE555/566/565	
9.	Digital IC	
10.	LM371/ LM723	
11.	ICSG3524 / SG3525	
12.	Transistor – 2N3391	
13.	Diodes, IN4001 BY126	
14.	Zener diodes	
15.	Step-down transformer 230V/12-0-012V	
16.	Resistors ¼ Watt Assorted, Capacitors, Single strand wire etc.	

COURSE OUTCOMES:

At the end ofthe course thestudentswouldbeableto

CO1 : Realize and implement Boolean Functions.

CO2 : Perform code conversion and to understand its importance

CO3: Design and implement circuits with digital ICs like decoders, multiplexers, register

CO4: Acquire knowledge on Application of Op-Amp

CO5: Design and implement counters using analog ICs like timers and VCOs

CO6: Design and implement counters using digital ICs like Flip-flops and counters

U23CSP33	C PROGRAMMING AND DATA STRUCTURES LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To develop applications in C
2. To implement linear and non-linear data structures
3. To understand the different operations of search trees
4. To get familiarized to sorting and searching algorithms

LIST OF EXPERIMENTS

1. Practice of C programming using statements, expressions, decision making and iterative statements
2. Practice of C programming using Functions and Arrays
3. Implement C programs using Pointers and Structures
4. Implement C programs using Files
5. Development of real time C applications
6. Array implementation of List ADT
7. Array implementation of Stack and Queue ADTs
8. Linked list implementation of List, Stack and Queue ADTs
9. Applications of List, Stack and Queue ADTs
10. Implementation of Binary Trees and operations of Binary Trees
11. Implementation of Binary Search Trees
12. Implementation of searching techniques
13. Implementation of Sorting algorithms : Insertion Sort, Quick Sort, Merge Sort
14. Implementation of Hashing – any two collision techniques

TOTAL: 30 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Standalone Desktop PC's with required software	15 Nos.
2.	Any public domain or commercial software	-

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Use different constructs of C and develop applications

CO2 : Write functions to implement linear and non-linear data structure operations

CO3: Suggest and use the appropriate linear / non-linear data structure operations for a given problem

CO4: Apply appropriate hash functions that result in a collision free scenario for data storage and Retrieval

CO5: Implement Sorting algorithms for a given application

CO6: Implement searching algorithms for a given application

SEMESTER V

U23EET51	CONTROL SYSTEMS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Transfer function modelling of electrical and mechanical systems.
2. Time domain analysis for different types and order of the system.
3. Frequency domain analysis using various graphical methods.
4. Stability analysis of control system.
5. Design of compensators.

UNIT I SYSTEM MODELLING AND REPRESENTATION 12

System concepts- Classifications of control system with examples-Transfer function Modelling of Electrical systems, Mechanical systems (Translational & Rotational systems) - AC and DC Servomotors- Electrical Analogy of Mechanical Systems - Block diagram reduction techniques –Signal flow graphs– Mason' gain formula.

UNIT II TIME RESPONSE ANALYSIS 12

Standard test signals- Time response of First-order system for different input Signals - Time response of Second-order systems for step input signal - Time domain specifications - Steady state error constants: Position, Velocity and Acceleration error constants- Generalized error series – Transfer function model and characteristics of P, PI, PD and PID controllers.

UNIT III STABILITY ANALYSIS 12

Characteristics equation –Concepts of Stability - Location of roots in S-plane for stability- Routh-Hurwitz Stability criterion – Necessary and sufficient conditions for stability– Root locus concept-Rules for construction of root loci- Root locus plot for stability analysis.

UNIT IV FREQUENCY RESPONSE ANALYSIS 12

Frequency domain specifications – Peak resonance, Resonant frequency, Bandwidth and Cut-off rate-Correlation between time and frequency responses for second order systems-Gain margin and phase margin – Bode plot method - Polar plot method - Stability analysis using Gain and Phase margin- Nyquist plot method.

UNIT V COMPENSATOR DESIGN & STATE VARIABLE MODEL 12

Compensators: Performance criteria – Lag and Lead compensators networks– Design of Lag, Lead and Lag-Lead compensators using Bode plot method. Concepts of State, State variable, State model-State models for simple electrical system– Phase variable model – Canonical model- Controllability and Observability using Kalman's test method

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Develop mathematical models of electrical and mechanical systems.
CO2: Estimate the time domain specifications.
CO3: Estimate the frequency domain specifications.
CO4: Analyze the performance and stability of system through time domain and frequency domain approach.
CO5: Frame various types of state space model of a system.
CO6: Frame various types of state space model of a system.

TEXT BOOKS:

1. Nagrath.J and Gopal.M," Control System Engineering", New Age International Publishers, Seventh edition 2021.
2. Richard C. Dorf & Robert H. Bishop, "Modern Control Systems", Pearson Education, 12th Edition 2011.

REFERENCE BOOKS:

1. Ogata K, "Modern Control Engineering", Prentice Hall of India, New Delhi, 2013.
2. Gopal M, "Control Systems – Principles and Design, Tata McGraw-Hill, New Delhi, 2024.
3. Gopal.M, "Digital Control and State Variable Methods", McGraw- Hill, 4th Edition, 2012.
4. Palani.S,"Control Systems Engineering", McGraw-Hill Education (India) Pvt Ltd, 4th Edition ,2012.
5. Richard C. Dorf & Robert H. Bishop, "Modern Control Systems", Pearson Education, 12th Edition 2011.
6. Schaum's Outline Series, "Feedback and Control Systems", McGraw- Hill, 2nd Edition, 2011.
7. Norman S Nise, "Control System Engineering", John Wiley & Sons, New Delhi, 2013.
8. Dhanesh N.Manik, "Control Systems", Cengage Learning, Delhi, 1st Edition, 2012.
9. Benjamin Kuo, ―Automatic Control Systems‖, Prentice Hall of India, New Delhi, 2010.

U23EET52	MICROPROCESSORS AND MICROCONTROLLERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Architecture of 8085 & 8051.
2. Addressing modes & instruction set of 8085 & 8051.
3. The need & use of Interrupt structure 8085 & 8051.
4. Developing skill for writing simple programs in 8051 & 8085 and applications.
5. Interfacing peripheral interface Ics.

UNIT I ARCHITECTURE AND PROGRAMMING OF 8085 MICROPROCESSOR 9

Functional Block Diagram - Instruction formats – Addressing modes – Instruction set – Need for Assembly language – Development of Assembly language programs – Assembler Directives - Machine cycles and Timing diagrams.

UNIT II INTERRUPTS MEMORY AND I/O DEVICE INTERFACING 9

Interrupts: Interrupt feature – Need for interrupts - Types of Interrupts – Interrupt structure and their handling. Memory Interfacing: Interface requirements -Wait states – Memory control signals – Read and write cycles –Typical ROM and RAM Interfacing. Memory mapped I/O scheme – I/O mapped I/O scheme –Simple I/O ports.

UNIT III PERIPHERAL IC INTERFACING 9

Study of Architecture and programming of ICs: 8255 PPI, 8251 USART, 8279 Key board display controller and 8253 Timer/ Counter – Interfacing with 8085.

UNIT IV 8051 MICROCONTROLLER 9

Functional block diagram - Instruction format and addressing modes – Instruction Set –Simple programs interrupt structure, Timer –I/O ports – Serial communication.

UNITV APPLICATIONS OF MICROPROCESSOR AND MICROCONTROLLER 9

Memory interfacing seven segment LED Display systems - Interfacing LCD Display - Stepper motor control - Interfacing A/D Converter –D/A Converter – Waveform generators.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Develop programming of 8085 microprocessor based on its architecture.
CO2: Design and Implement the Memory interface and interrupt with 8085 Processor
CO3: Design and Implement the Peripheral Devices interface with 8085 Processor
CO4: Develop programming of 8051 microcontroller based on its architecture.
CO5: Design and Implement the Memory & Peripheral Devices interface with 8051
CO6: Understand and appreciate advanced architecture evolving microprocessor field

TEXT BOOKS:

1. Gaonkar R.S., “Microprocessor Architecture, Programming and its Applications with 8085”, Penram Publications, 6th Edition, 2013.
2. Senthil Kumar N.,Saravanan M., Jeevananthan.S, “Microprocessors and Microcontrollers” Oxford University Press, New Delhi, second edition 2016.
3. Kenneth Ayala, “8051 Microcontroller”, Cengage Learning India Pvt. Ltd 2004

REFERENCE BOOKS:

1. Muhammad Ali Mazidi & Janice Gilli Mazidi, R.D.Kinley "The 8051 Micro Controller and Embedded Systems", PHI Pearson Education, 5th Indian reprint, 2007.
2. Krishna Kant, "Microprocessor and Microcontrollers", Eastern Company Edition, Prentice – Hall of India, New Delhi, 2013.
3. Rafiquzzaman. M, "Microprocessors Theory and applications - Intel and Motorola", Prentice Hall, India, 2018.
4. Douglas V.Hall, "Microprocessors and Digital Systems", McGraw Hill Publishing Co. Ltd. 1983.

U23EET53	PROTECTION AND SWITCHGEAR	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Understanding Importance of protection, protection schemes and earthing.
2. Knowing Characteristics, functions and application areas of relays and circuit breakers.
3. Describing Common faults in major power system apparatus and selection of suitable protective schemes.
4. Apply Problems associated with circuit breaking.
5. UnderstandingVarious circuit breakers and methods of testing

UNIT I INTRODUCTION 9

Importance of protective schemes for electrical apparatus and power system. Types of protective schemes - Types of faults, fault statistics and effects of faults - relay terminologies – essential qualities of protection. Power System earthing and types of earthing.

UNIT II PROTECTIVE RELAYS 9

Protective Transformers: CTs and PTs – operating principle and construction – types and applications. Relays: Electromagnetic relays – over current, directional and non-directional, distance, negative sequence, differential and under frequency relays – Introduction to static relays and Numerical relays.

UNIT III APPARATUS PROTECTION 9

Alternator : Stator protection - Percentage differential protection - Protection against stator inter-turn faults - Stator overheating protection - Rotor protection - Field ground fault protection - Loss of excitation - Rotor overheating protection – Field suppression. Transformer: Common faults – Buchholz relay – differential protection. Transmission line: Time graded protection - distance protection of HV and EHV lines - Pilot wire protection - Carrier current protection. Bus bar: Fault bus and Differential schemes.

UNIT IV THEORY OF CIRCUIT INTERRUPTION 9

Physics of arc phenomena and arc interruption. Theories for arc interruption - AC circuit breaking - restriking voltage and recovery voltage - rate of rise of recovery voltage - resistance switching - current chopping - interruption of capacitive current. DC circuit breaking.

UNITV CIRCUIT BREAKERS 9

Types of circuit breakers – Construction and working principle- Oil, air blast, air break, SF6 and vacuum circuit breakers –Advantages and disadvantages of various circuit breakers – Ratings of CBs – Testing of circuit breakers

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Select proper earthing for the power system apparatus and components.

CO2: Suggest the types of relays for specific applications

CO3: Identify the protective schemes for safeguarding major power system apparatus and components

CO4: Apply suitable methods for quenching arc

CO5: Summarize the merits and application areas of various Protective transformers.

CO6: Explain circuit breaker based on application requirements.

TEXT BOOKS:

1. M.L. Soni, P.V. Gupta, V.S. Bhatnagar, A. Chakrabarti, 'A Text Book on Power System Engineering', Dhanpat Rai & Co., 2017.
2. Badri Ram, Vishwakarma, 'Power System Protection and Switchgear', McGraw Hill, 2022

REFERENCE BOOKS:

1. Sunil S. Rao, 'Switchgear and Protection', Khanna publishers, New Delhi, 2022.
2. C.L. Wadhwa, 'Electrical Power Systems', New Age International (P) Ltd., 2009.
3. B. Ravindranath, and N. Chander, 'Power System Protection & Switchgear', Wiley Eastern Ltd., 2005.
4. Y.G. Paithankar and S.R. Bhide, 'Fundamentals of Power System Protection', Prentice Hall of India Pvt. Ltd., New Delhi–110001, 2003.
5. V.K.Mehta and Rohit Mehta, 'Principles of Power System'. S.Chand & Company Limited, Revised Edition, 2005.

U23EET54	PRINCIPLES OF DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students

1. To Classify signals and systems & their mathematical representation.
2. To Analyse of discrete-time systems using different types of transforms.
3. To Design Digital Filters.
4. To Analyse using Discrete Fourier Transform.
5. To Explain computation techniques.

UNIT I INTRODUCTION TO SIGNALS AND SYSTEMS 9

Classification of systems: Continuous, discrete, linear, causal, stable, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; operation of signals, spectral density; sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect.

UNIT II DISCRETE TIME SYSTEM ANALYSIS 9

Z-transform and its properties, inverse z-transforms; difference equation – Solution by z-transform, application to discrete systems - Stability analysis, frequency response – Convolution – Analysis of LTI Systems in z-domain.

UNIT III DISCRETE FOURIER TRANSFORM & COMPUTATION 9

DFT properties, magnitude and phase representation - Computation of DFT using FFT algorithm – DIT & DIF - FFT using radix 2 – Butterfly structure – Application of DSP in power quality analysis.

UNIT IV DESIGN OF FIR FILTERS 9

FIR design: Windowing Techniques (Rectangular, Triangular, Hamming, Hanning windows only) – Need and choice of windows – Linear phase characteristics.

UNITV DESIGN OF IIR FILTERS AND FILTER REALIZATION 9

IIR design: Analog filter design - Butterworth and Chebyshev approximations - digital design using impulse invariant and bilinear transformation - Warping, prewarping. FIR & IIR filter realization – Direct, Parallel &Cascade forms.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Apply the concepts of digital signal processing.
CO2: Analyze the discrete-time systems using Z- transform.
CO3: Apply FFT algorithm for computing DFT of discrete signal.
CO4: Design suitable digital FIR filter for the required specifications.
CO5: Design suitable digital IIR filter for the required specifications.
CO6: Apply DSP in power quality analysis.

TEXT BOOKS:

1. John G Proakis, Dimtris G Manolakis, “Digital Signal Processing Principles, Algorithms and Application”,PHI, 3rd Edition, 2012.
2. Salivahanan S, “Digital Signal Processing”, McGraw-Hill / TMH, 2019.

REFERENCE BOOKS:

1. Alan V. Oppenheim, Ronald W. Schafer and John R. Buck, 'Discrete – Time Signal Processing',Pearson Education, New Delhi, 2011.
2. Johny R.Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 2023.
3. Mitra S.K., "Digital Signal Processing - A Computer based approach", McGraw-Hill, New Delhi, 2001.

U23EEP51	MEASUREMENTS AND CONTROL SYSTEMS LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students :

1. To Measure various electrical quantities.
2. To calibrate energy meter and current transformer.
3. To determine transfer function model of electro mechanical system.
4. To Simulate second order systems with controllers using MATLAB.
5. To understand Stability analysis of linear system using various graphical methods.

LIST OF EXPERIMENTS

1. DC Bridges: Wheatstone Bridge & Kelvin's Double Bridge.
2. AC Bridges: Maxwell's Bridge & Schering Bridge.
3. Calibration of Current Transformers and Potential transformers.
4. Calibration of Energy meter by Phantom loading.
5. Performance characteristics of Displacement, Pressure and Temperature transducers.
6. Measurement of 3- Φ Power and Power factor in a balanced 3- Φ circuit by using two 1- Φ Wattmeter.
7. Measurement of Iron loss and Magnetic permeability of a given Ring Specimen
8. Transfer Function of Armature Controlled D.C Motor.
9. Transfer Function of Field Controlled D.C Motor.
10. Transfer Function of A.C Servomotor.
11. Transfer Function of Separately Excited D.C Shunt Generator.
12. Digital Simulation of Second-order Systems for obtaining the time response of a system under various damping conditions.
13. Stability Analysis of Linear Systems using Bode, Root locus & Nyquist plots method using simulation software.
14. Estimate the Effect of P, PI, PD and PID Controllers on the Linear Second-order system.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	PID controller simulation and learnerkit	1
2.	Digital storage Oscilloscope for capturingtransients	1
3.	Personal Computer with control system simulationpackages	10
4.	DC motor –Generator test set-up for evaluation of motorparameters	
5.	CRO 30MHz	1
6.	2MHz FunctionGenerator	1
7.	Position Control Systems Kit (withmanual)	1
8.	Tacho Generator Coupling set	1
9.	Sufficient number of Digital multi meters, speed and torque sensors	
10.	R, L, C Bridge kit (withmanual)	
11.	Electricheater	1
12.	Single phase Autotransformer	1
13.	IC Transistorkit	1
14.	Instrumentation Amplifierkit	1
15.	Analog – Digital and Digital –Analog converters (ADC andDACs)	1

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Measure various electrical Parameters using various bridges.
CO2: Familiar with calibration of energy meter and current transformer.
CO3: Determine the transient response of simple electrical circuits.
CO4: Model the transfer function of electromechanical systems.
CO5: Determine the stability of linear systems.
CO6: Determine the transfer function of various motors and generator.

U23EEP52	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students to:

1. Perform simple arithmetic operations using assembly language program and study the addressing modes of 8051.
2. Programme of 8085 using and its instruction set. Programming using 8085A
3. Programme of 8051 based controller using the Keil development tool.
4. Interface peripheral devices such as keyboard, ADC, DAC, stepper motor and USART with 8051.
5. Interfacing peripheral devices such as keyboard, ADC, DAC, stepper motor and USART with 8051.

LIST OF EXPERIMENTS

1. Addition, subtraction, multiplication and division using 8085 processor
2. Programming of array handling and sorting using 8085 microprocessor
3. Interfacing ADC with 8085
4. Interfacing DAC with 8085
5. Interfacing matrix keyboard and multiplexed display with 8085 using 8279
6. Multi precision addition, multiplication and division using 8051
7. Code conversion: binary to ASCII and binary to BCD code conversion using 8051
8. Stepper motor control using 8051
9. LCD interface with 8051
10. Study of Integrated Development Environment tool for 8051 based system

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	8085 Microprocessor Trainer with Power Supply	15
2.	8051 Micro Controller Trainer Kit with power supply	15
3.	8255 Interface boards	5
4.	8251 Interface boards	5
5.	8259 Interface boards	5
6.	8279 Keyboard / DisplayInterfaceboards	5
7.	8254 timer/counters	5
8.	ADC and DAC cards	5
9.	AC & DC motor withControllers	5
10.	Traffic Light ControlSystems	5

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Develop skills in simple program writing in assembly languages.

CO2: Develop programming of 8085 microprocessor based on its architecture and instruction set.

CO3: Design and Implement the Peripheral Devices interface with 8085 Processor.

CO4: Develop programming of 8051 microcontroller based on its architecture and instruction set.

CO5: Design and Implement the Peripheral Devices interface with 8051 hardware components.

CO6: Ability to analyze, comprehend, design and simulate microcontroller and microprocessor based systems used for control and monitoring.

SEMESTER VI

U23EET61	POWER ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Different types of power semi-conductor devices and their switching characteristics.
2. The operation, switching techniques and basic topologies of DC-DC switching regulators.
3. The operation, characteristics and performance parameters of controlled rectifiers.
4. The different modulation techniques of pulse width modulated inverters and to understand the harmonic reduction methods.
5. The operation of AC-AC converters.

UNIT I POWER SEMI-CONDUCTOR DEVICES 9

Introduction to Power Electronics - Study of switching devices: structure, operation, static and switching characteristics of Power DIODE, SCR, TRIAC, BJT, MOSFET, IGBT. SCR: Two Transistor model, Triggering Methods and Snubber circuits.

UNIT II DC TO DC CONVERTER 9

Step-down and Step-up chopper - Time ratio control and Current limit control – Buck, Boost, Buck-Boost and Cuk converter - Concept of Resonant switching.

UNIT III PHASE-CONTROLLED CONVERTERS 9

1-pulse, 2-pulse converters - circuit, operation, waveforms - Estimation of average load voltage and average load current for continuous current operation - Input power factor estimation for ripple free load current - Effect of source inductance – Single phase dual converters - 3-pulse and 6-pulse converters – circuit, operation, waveforms - Estimation of average load voltage.

UNIT IV INVERTERS 9

Types of Inverter – Voltage Source Inverter and Current Source Inverter – VSI: Single phase and three phase inverters (both 120 degree mode and 180 degree mode) - PWM techniques: single, multiple, sinusoidal PWM – Voltage and harmonic control - CSI: Capacitor commutated CSI - UPS – types of UPS.

UNITV AC TO AC CONVERTERS 9

Single phase AC voltage controllers –Integral cycle control, phase angle control - Estimation of RMS load voltage, RMS load current and input power factor - sequence control - Single phase to single phase cyclo-converters.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Identify and select the switching devices for different power converter applications.
CO2:	Design and analyze different DC-DC converter with various loads.
CO3:	Design a suitable power converter for given dc load specification from AC input.
CO4:	Design and analyze the single phase inverter and three phase inverters.
CO5:	Explain the concepts of AC-AC converters.
CO6:	Design and analyse various pulse converters.

TEXT BOOKS:

1. Rashid M H, " Power Electronics: Circuits, Devices and Applications ", Pearson Education, India, 4th Edition, 2017.
2. P.S.Bimbhra P.S., “Power Electronics“ Khanna Publishers, 6th Edition 2018.

REFERENCE BOOKS:

1. Ned Mohan, Tore M. Undeland, William P. Robbins, “Power Electronics - Converters, Applications and Design”, Wiley India, 3rd Edition, 2018.
2. Vedam Subrahmanyam, "Power Electronics", New Age International (P) Limited, New Delhi, 2nd Edition. 2018.
3. Philip T Krein, “Elements of Power Electronics”, Oxford University Press, 2017.
4. Soumitra Kumar Mandal., “Power Electronics”, McGraw Hill publishers Pvt. Ltd., 2014.

U23EET62 **EMBEDDED SYSTEMS**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To introduce the Building Blocks of Embedded System.
2. To Educate in Various Embedded Development Strategies.
3. To Introduce Bus Communication in processors, Input/output interfacing.
4. To impart knowledge in Various processor scheduling algorithms.
5. To introduce Basics of Real time operating system and example tutorials to discuss on one real- time operating system tool

UNIT I INTRODUCTION TO EMBEDDED SYSTEMS 9

Introduction to Embedded Systems – The build process for embedded systems- Structural units in Embedded processor , selection of processor & memory devices- DMA – Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging.

UNIT II EMBEDDED NETWORKING 9

Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols - RS232 standard – RS422 – RS485 - CAN Bus -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) –need for device drivers.

UNIT III EMBEDDED FIRMWARE DEVELOPMENT ENVIRONMENT 9

Embedded Product Development Life Cycle- objectives, different phases of EDLC, Modelling of EDLC; issues in Hardware-software Co-design, Data Flow Graph, state machine model, Sequential Program Model, concurrent Model, object oriented Model.

UNIT IV DESIGN OF ARITHMETIC BUILDING BLOCKS USING VLSI 9

Arithmetic Building Blocks: Data Paths, Adders, Multipliers, Shifters, ALUs, power and speed tradeoffs, Case Study: Design as a tradeoff. Designing Memory and Array structures: Memory Architectures and Building Blocks, Memory Core, Memory Peripheral Circuitry.

UNITV EMBEDDED APPLICATION AND VLSI IMPLEMENTATION STRATEGY 9

Case Study of Washing Machine- Automotive Application- Smart card System Application,.FPGA Building Block Architectures, FPGA Interconnect Routing Procedures. Design for Testability: Ad Hoc Testing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Operate various Embedded Development Strategies.
CO2: Suggest an embedded system for a given application.
CO3: Understand and analyze Embedded systems.
CO4: Understand basics of Real time operating system.
CO5: Acquire knowledge on various processor scheduling algorithms.
CO6: Design memory and array structures.

TEXT BOOKS:

1. Rajkamal, 'Embedded System-Architecture, Programming, Design', Mc Graw Hill, 2013.
2. Peckol, "Embedded system Design", John Wiley & Sons,2019.
3. Lyla B Das," Embedded Systems-An Integrated Approach", Pearson, 2013.

REFERENCE BOOKS:

1. Shibu. K.V, "Introduction to Embedded Systems", Tata Mcgraw Hill,2016.
2. Elicia White," Making Embedded Systems", O' Reilly Series,SPD,2011.
3. Tammy Noergaard, "Embedded Systems Architecture", Elsevier, 2013.
4. Han-Way Huang, "Embedded system Design Using C8051", Cengage Learning,2015.
5. Rajib Mall "Real-Time systems Theory and Practice" Pearson Education, 2007.

U23EET63	POWER SYSTEM ANALYSIS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Different aspects of modelling of system components.
2. Steady-state operation of large-scale power systems.
3. Solving power flow problems using efficient numerical methods suitable for computer simulation.
4. Concept of symmetrical and un-symmetrical faults in power system studies.
5. Analyzing the dynamics of power system for small-signal and large signal disturbances

UNIT I INTRODUCTION 12

Structure of Power system - Basic Components of a power system and its modeling - Single line diagram – Impedance diagram – Reactance diagram - Per Phase Analysis -Per unit system - Simple bus building algorithms for the formation of Y-Bus matrix

UNIT II POWER FLOW ANALYSIS 12

Importance of power flow analysis in planning and operation of power systems-Statement of power flow problem - Bus Classifications – power flow solution methods -Gauss Seidal method - Newton Raphson method (polar form) - Fast decoupled method (qualitative study only) - Flow charts - Comparison.

UNIT III SYMMETRICAL FAULT ANALYSIS 12

Need of short circuit analysis - Symmetrical three phase fault- Short circuit capacity- Bus building algorithm for the formulation of Z – Bus matrix - systematic fault analysis using bus impedance matrix (Bus frame analysis).

UNIT IV UNSYMMETRICAL FAULT ANALYSIS 12

Fundamentals of symmetrical components – sequence impedances – sequence networks representation – single line to ground fault – line to line fault - Double line to ground fault.

UNIT V POWER SYSTEM STABILITY ANALYSIS 12

Importance of stability analysis in power system planning and operation – Types of stability - Basic concepts and definitions – Rotor angle stability - Swing equation- Solution of swing equation by step by step method (Method 2) – An elementary view of transient stability – Equal area criterion – critical clearing angle and time- Numerical integration methods (Algorithm and flow chart) for multi-machine stability analysis – Euler method – modified Euler method.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Do modelling for various power system components.
CO2: Distinguish between different methods of power flow analysis.
CO3: Design the protective gadgets based on short circuit capacity.
CO4: Analyze the nature of the system for various fault conditions.
CO5: Identify the stability of Power system.
CO6: Analyse the equal area criterion by various methods.

TEXT BOOKS:

1. John J. Grainger and W.D. Stevenson Jr., “Power System Analysis”, McGraw Hill International Book Company, 1st Edition, 2021.
2. Nagrath I.J. and Kothari D.P., “Modern Power System Analysis”, McGraw-Hill Publishing Company, New Delhi, 2022.
3. Hadi Saadat, “Power System Analysis”, McGraw Hill Publishing Company, New Delhi, 2002.
4. P. Venkatesh, B. V. Manikandan, A. Srinivasan, S. Charles Raja, “Electrical Power Systems: Analysis, Security and Deregulation” Prentice Hall India (PHI), second edition - 2017.

REFERENCE BOOKS:

1. Wadhwa C L, "Electrical Power Systems", New Age International Publishers, Delhi, 2006 Seventh Edition Reprint Aug, 2017.
2. Kundur P., “Power System Stability and Control”, McGraw Hill, Publications, 2022.
3. Olle. I. Elgerd, “Electric Energy Systems Theory – An Introduction”, McGraw Hill Publishing Company Limited, New Delhi, Second Edition, 2013.
4. Pai M.A., “Computer Techniques in Power System Analysis”, McGraw – Hill Publishing Company, New Delhi, 2014.
5. Gupta B.R., “Power System Analysis and Design”, S. Chand, New Delhi, 2024.

U23EET64	HIGH VOLTAGE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To understand the various types of over voltages in power system and protection methods.
2. Generation of over voltages in laboratories.
3. Measurement of high voltages and high currents.
4. Nature of Breakdown mechanism in solid, liquid and gaseous dielectrics.
5. Testing of power apparatus and insulation coordination.

UNIT I OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS 9

Causes of over voltages and its effects on power system – Lightning, switching surges and temporary over-voltages, Corona and its effects – Reflection and Refraction of Travelling waves- Protection against over-voltages.

UNIT II DIELECTRIC BREAKDOWN 9

Gaseous breakdown in uniform and non-uniform fields – Corona discharges – Vacuum breakdown – Conduction and breakdown in pure and commercial liquids, Maintenance of oil Quality – Breakdown mechanisms in solid and composite dielectrics.

UNIT III GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS 9

Generation of High DC, AC, impulse voltages and currents - Triggering and control of impulse generators.

UNIT IV MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS 9

High Resistance with series ammeter – Dividers, Resistance, Capacitance and Mixed dividers - Peak Voltmeter, Generating Voltmeters - Capacitance Voltage Transformers, Electrostatic Voltmeters – Sphere Gaps - High current shunts- Digital techniques in high voltage measurement.

UNITV HIGH VOLTAGE TESTING & INSULATION COORDINATION 9

High voltage testing of electrical power apparatus as per International and Indian standards – Power frequency, impulse voltage and DC testing of Insulators, circuit breakers, bushing, isolators and transformers- Insulation Coordination.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Ability to understand and analyze power system over voltage and protection.
CO2: Understand breakdown mechanism in pure and commercial liquids.
CO3: GenerateHVAC, HVDC and HV impulse voltages and currents.
CO4: Measure HVAC, HVDC and HV impulse voltages and currents.
CO5: Test high voltage electrical apparatus as per standards.
CO6: Understand the importance of insulation in electrical components

TEXT BOOKS:

1. S.Naidu and V. Kamaraju, 'High Voltage Engineering', Tata McGraw Hill, Fifth Edition, 2019.
2. E. Kuffel and W.S. Zaengl, J.Kuffel, 'High voltage Engineering fundamentals', Newnes Second Edition Elsevier , New Delhi, 2005.

REFERENCE BOOKS:

1. L.L. Alston, 'High Voltage Technology', Oxford University Press, First Indian Edition, 2011.
2. C.L. Wadhwa, 'High voltage Engineering', New Age International Publishers, Fourth Edition, 2024.

U23EEP61	POWER ELECTRONICS AND DRIVES LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Single phase and three phase AC-DC converters fed dc drives.
2. Chopper fed dc motor drives and Inverter fed induction motor drives.
3. Simulation of basic topological power converter circuits.
4. Single phase AC voltage controller.
5. Simulation of single phase cycloconverter.

LIST OF EXPERIMENTS

1. Characteristics of SCR and TRIAC.
2. Characteristics of MOSFET and IGBT.
3. Single phase semi converter with R, RL and RLE load.
4. Single phase full converter with R, RL and RLE load.
5. Three phase full converter with R Load.
6. Step down Chopper with R, RL and RLE load.
7. Step up Chopper with R and RL load.
8. Single Phase PWM inverter.
9. Speed control of three phase induction motor using inverter.
10. Single phase AC voltage Controller.
11. Generation of PWM signals using micro controller.
12. Single Phase Cycloconverter.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Device characteristics(for SCR, MOSFET, TRIAC,GTO,IGCTand IGBT kit with built-in / discrete power supplyandmeters)	2
2.	MOSFET based step up and step down choppers (Builtin/Discrete)	1
3.	IGBT based single phase PWM invertermodule/DiscreteComponent	2
4.	IGBT based three phase PWM invertermodule/DiscreteComponent	2
5.	Switched mode power convertermodule/DiscreteComponent	2
6.	SCR &TRIAC based 1 phase AC controller along with lamp orrheostatload	2
7.	Cyclo converter kit withfiringmodule	1
8.	CathoderayOscilloscope	10
9.	IsolationTransformer	5
10.	Single phaseAutotransformer	3
11.	Components (Inductance,Capacitance)	3
12.	Multimeter	5
13.	LCRmeter	3
14.	DC and AC meters ofrequiredranges	10

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Differentiate the characteristics of power Electronics switches.
CO2:	Design and analyze the single phase and three phase controlled rectifiers fed DC drives.
CO3:	Design and analyze the choppers and chopper fed dc drives.
CO4:	Analyze the inverter operation and inverter fed induction motor drives.
CO5:	Analyze the performance of AC-AC converters.
CO6:	Simulate the power converter topologies.

U23HS61	COMPREHENSIVE SKILL DEVELOPMENT	L	T	P	C
		0	0	3	1

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. The aim of the comprehension course is to enhance the employability skills of students with a special focus on Presentation skills,
2. Group discussion skills, Interview skills.
3. Arithmetic, Analytic & Verbal knowledge skills through periodic exercise which are necessary for the workplace situations.
4. Training in soft skills,peoples skills.
5. Skills on interview,dress code,bodylanguage.

UNIT I WEEKLY NEWS **9**

From Dailies, weekly and other Magazines, State News, National News, International News, Science and Technology development news and Sports News.

UNIT II TECHNICAL SEMINAR **9**

Making presentations: introducing a topic -Preparing effective PPTs – presenting the visuals effectively–Technical seminars- answering questions – individual presentation practice. From the previous UG projects, Academic subjects, from Electronics for You, from Electrical India, other Technical Magazines & Journals.

UNIT III GROUP DISCUSSION **9**

Participating in group discussions – understanding group dynamics – brainstorming the topic.

UNIT IV APTITUDE TEST **9**

Technical - General (Arithmetic, Analytic, Verbal) - Apply technical knowledge to write Technical Aptitude test for succeeding in any competitive examinations. Apply Arithmetic, Analytic and Verbal knowledge to write General Aptitude test and for succeeding in any competitive examinations.

UNITV MOCK INTERVIEW **9**

Imparting training in soft skills - persuasive skills – People skills - questioning and clarifying skills – Interview 68 etiquette – dress code – body language – mock interview. Enable them to gain confidence to face the placement interviews & react to the questions posed.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Enhance the employability skills.
CO2: Prepare and present Technical Seminar effectively.
CO3: Find out optimum solution for societal problem through group discussion.
CO4: Succeed in competitive examination.
CO5: Confidence to face the interview.
CO6: Development in dress code and body language.

TEXT BOOKS:

1. Meenakshi Raman and Sangeetha Sharma. "Technical Communication- Principles and Practice", Oxford University Press, 2009.
2. Dhanavel.S.P, "English and Communication Skills for Students of Science and Engineering", Orient Blackswan Ltd., 2009.
3. Agarwal.R.S , "Quantitative Aptitude for Competitive Examinations", S.Chand Limited 2011.

REFERENCE BOOKS:

1. Abhijit Guha, "Quantitative Aptitude for Competitive Examinations", McGraw Hill, 3rd Edition, 2011.
2. Edgar Thrope, "Test of Reasoning for Competitive Examinations", McGraw Hill, 4th Edition, 2012.

SEMESTER VII

U23EET71	POWER SYSTEM OPERATION AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Operation of power system.
2. Modelling the power system for real power-frequency
3. Modelling the power system for reactive power
4. Modelling the power system for voltage control.
5. Concepts of computer control of power systems.

UNIT I INTRODUCTION 9

System load – variation - load characteristics - load curves and load-duration curve (daily, weekly and annual) - load factor - diversity factor- Introduction to restructuring of power systems. Importance of load forecasting -simple techniques. An overview of power system operation and control.

UNIT II REAL POWER - FREQUENCY CONTROL 9

Fundamentals of speed governing mechanism and modeling - speed-load characteristics – load sharing between two synchronous machines in parallel. Concept of control area- LFC control of a single-area system. Static and dynamic analysis of uncontrolled and controlled cases. Integration of economic dispatch control with LFC. Two area system – modeling – static and dynamic analysis - uncontrolled case, tie line with frequency bias control of two-area system, state variable model –two area system.

UNIT III REACTIVE POWER–VOLTAGE CONTROL 9

Basics of reactive power control. Types of Excitation system – AVR modeling. Static and dynamic analysis - stability compensation - generation and absorption of reactive power. Relation between voltage, power and reactive power at a node. Method of voltage control - tap-changing transformer, SVC (TCR + TSC) and STATCOM. System level control using generator voltage magnitude setting, tap setting of OLTC transformer.

UNIT IV ECONOMIC DISPATCH AND UNIT COMMITMENT 9

Introduction- economic dispatch problem – cost of generation – incremental cost curve - co-ordination equations without loss and with loss, solution by direct method and λ-iteration method. (No derivation of loss coefficients).Base Point and participation factors. Economic dispatch controller added to LFC control. Statement of Unit Commitment problem – constraints; spinning reserve, thermal unit constraints, hydro constraints, fuel constraints and other constraints. UC Solution methods - Priority-list methods. Numerical problems only in priority-list method using full-load average production cost.

UNIT V COMPUTER CONTROL OF POWER SYSTEMS 9

Need of computer control of power system. Energy control centre: Functions - system monitoring - data acquisition and control. System hardware configuration – SCADA and EMS functions. Network topology - state estimation - security analysis and control. Various operating states (Normal, alert, emergency, in-extremis and restorative) showing various state transitions and control strategies- System Black out (Case studies).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Describe power system behavior, operations and control.

CO2: Explain the modeling of Real Power and Frequency Control.

CO3: Explain the analysis of Frequency Control.

CO4: Explain the modeling and analysis of Reactive Power and Voltage Control

CO5: Analyze the optimal dispatch problems and unit commitment in various power plants

CO6: Describe the principles of computer control of power system

TEXT BOOKS:

1. Dr.K.Uma Rao , “Power System Operation and Control”, Wiley India Pvt .Ltd. New Delhi, 2016
2. Abhijit Chakrabarti, Sunita Halder, “Power System Analysis Operation and Control”, PHI learning Pvt. Ltd., Third Edition, 2024.

REFERENCE BOOKS:

1. A.K., Kothari D.P., Ahson S., “Computer Aided Power System Analysis and Control”, McGraw Hill Publishing Company Limited, 1988.
2. Gupta B.R., Vandana Singhal ‘Power System operation and control’, S.Chand Publications, Reprint 2014.
3. Murty P.S.R., ‘Operation and Control in Power Systems’, B.S. Publications, First Edition, 2007.
4. Kirchmayer, Leon.K, ‘Economic Operation of Power Systems’ Wiley Eastern Limited, 1985.
5. Weedy. B.M., Cory B.J., ‘Electric Power Systems’ John Wiley & Sons, Ltd, 2004.
6. Ramana N.V., “Power System Operation and Control,” Pearson, 2011.
7. Allen.J.Wood and Bruce F.Wollenberg, “Power Generation, Operation and Control”, John Wiley & Sons, Inc., 2013.
8. Kundur P., “Power System Stability and Control”, McGraw Hill Education, 2022.

U23GET61	HUMAN VALUES AND ETHICS	L	T	P	C
		3	0	0	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Teach definition and classification of values.
2. Explain Purusartha.
3. Describe Sarvodaya idea.
4. Summarize sustenance of life.
5. Conclude views of hierarchy of values.

UNIT I DEFINITION AND CLASSIFICATION OF VALUES 9

Extrinsic values- Universal and Situational values- Physical- Environmental-Sensuous-EconomicSocial-Aesthetic-Moral and Religious values.

UNIT II CONCEPTS RELATED TO VALUES 9

Purusartha-Virtue- Right- duty- justice- Equality- Love and Good.

UNIT III IDEOLOGY OF SARVODAYA 9

Egoism- Altruism and universalism- The Ideal of Sarvodaya and Vasudhaiva Kutumbakam.

UNIT IV SUSTENANCE OF LIFE 9

The Problem of Sustenance of value in the process of Social, Political and Technological Changes.

UNITV VIEWS ON HIERARCHY OF VALUES 9

The Problem of hierarchy of values and their choice, The views of Pt. Madan Mohan Malviya and Mahatma Gandhi.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end ofthe course the students would be able to

CO1 : Understand definition and classification of values.
CO2 : Understand purusartha.
CO3: Understand sarvodaya idea.
CO4: Understand sustenance of life.
CO5: Understand the hierarchy of values.
CO6: Compare hierarchialviews of Pt. Madan Mohan Malviya and Mahatma Gandhi.

TEXT BOOKS:

1. Awadesh Pradhan : MahamanakeVichara. (B.H.U., Vanarasi-2007)
2. Little, William, : An Introduction of Ethics (Allied Publisher, Indian Reprint 2021)
3. William, K Frankena : Ethics (Prentice Hall of India, 1988)

U23EEP71	POWER SYSTEM SIMULATION LABORATORY	L	T	P	C
		0	0	3	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Analysis of load flow methods
2. Analysis of power systems
3. Simulation of power systems
4. Operation of power systems
5. Control of power systems

LIST OF EXPERIMENTS

1. Computation of Parameters and Modelling of Transmission Lines.
2. Formation of Bus Admittance Matrix of a network.
3. Formation of Bus Impedance Matrix of a network.
4. Load Flow Analysis by Gauss-Seidel Method.
5. Load Flow Analysis by Newton-Raphson and Fast-Decoupled Methods.
6. Symmetrical Fault Analysis
7. Unsymmetrical Fault Analysis.
8. Transient Stability Analysis of Single-Machine Infinite Bus System.
9. Load – Frequency Dynamics of Single- Area and Two-Area Power Systems.
10. Economic Dispatch in Power Systems
11. State estimation: Weighted least square estimation
12. Electromagnetic Transients in Power Systems : Transmission Line Energization

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Personal computers (Intel i3,80GB,2GBRAM)	30
2.	Printer laser	1
3.	Dot matrix	1
4.	Server (Intel i5, 80GB, 2GB RAM) (High speed processor)	1
5.	Software: any power system simulation software with 5 user license	
6.	Compilers: C, C++, VB, VC++	30 users

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Develop C/C++ programs for power system.
CO2 :	Use standard software packages for Power flow analysis, Fault analysis, Transient stability analysis and Load-Frequency Dynamics and control of power
CO3:	Evaluate performance evaluation of transmission lines,
CO4:	To understand formation of bus admittance and impedance matrices,
CO5:	Solving Economic Dispatch problems and for performing state estimation.
CO6:	Analyzing Electromagnetic Transients in Power Systems.

U23EEP72	ELECTRICAL DESIGN AND GREEN ENERGY LABORATORY	L	T	P	C
		0	0	3	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Electrical engineering concepts through hardware implementation
2. Practical implementation aspects and utility of green energy sources such as wind and solar energy systems.
3. Analysis the Grid connected and Stand alone Solar PV system
4. Understand fuel cell formation
5. Analysis Hybrid power systems

LIST OF EXPERIMENTS

1. Transformer oil Testing
2. Cable fault Identification
3. Harmonic analysis of Non-linear systems
4. Study on Shunt Active Power Filter
5. Study of Battery charging circuits
6. Experiment on performance assessment of Fuel cell
7. Experiment on V-I Characteristics and Efficiency of 1kW Solar PV system.
8. Experiment on Shadowing effect & diode based solution in 1kW Solar PV system
9. Experiment on Performance assessment of Grid connected and Stand alone 1kW Solar PV system
10. Experiment on Performance Assessment of micro wind energy generator (500W).
11. Experiment on Performance Assessment of Hybrid (Solar – Wind) Power System.
12. Simulation study on Solar PV Energy System under various shading conditions.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Personal computers (Intel i3, 80GB, 2GBRAM)	15
2.	CRO	9
3.	Digital Multimeter	10
4.	PV panels - 100W, 24V	1
5.	Battery storage system with charge anddischargecontrol 40Ah	1
6.	PVEmulator	1
7.	Micro Wind Energy Generator module	1
8.	Potentiometer	5
9.	Step-down transformer	5
10.	Component data sheets to be provided	

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Explain the practical issues related to applications using electrical and electronic equipment.
CO2:	Address variety of issues in harnessing Renewable Energy.
CO3:	Explain future role of Renewable energy sources in meeting global power demand.
CO4:	Explain fuel cell formation.
CO5:	Evaluate Performance assessment of Grid connected and Stand alone 1kW Solar PV system.
CO6:	Evaluate on Performance Assessment of Hybrid (Solar – Wind) Power System.

SEMESTER VIII

		L	T	P	C
U23EEP81	**PROJECT WORK**	**0**	**0**	**12**	**10**

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
2. To train the students in preparing project reports and to face reviews and viva voce examination.
3. The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor.
4. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester.
5. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 300 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

CO2 : Develop project management skills for effective planning and execution.

CO3: Collaborate in cross-functional teams to achieve project objectives.

CO4: Apply critical thinking and problem-solving techniques to address project challenges.

CO5: Foster creativity and innovation in project solutions and deliverables.

CO6: Communicate project progress and outcomes through effective presentations and reports.

VERTICAL I ENERGY AND POWER SYSTEMS

		L	T	P	C
U23EEV11	POWER QUALITY AND FLEXIBLE AC TRANSMISSION SYSTEMS	3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To learn the basic definitions in Power Quality.
2. To study the power quality issues in Single Phase and Three Phase Systems.
3. To understand the principles of Power System Harmonics.
4. To know the way to use DSTATCOM for Harmonic Mitigation.
5. To learn the concepts related with Series Compensation.

UNIT I INTRODUCTION 9

Introduction – Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non-linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.

UNIT II ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM 9

Single phase linear and non-linear loads – single phase sinusoidal, non-sinusoidal source – supplying linear and nonlinear loads – three phase balanced system – three phase unbalanced system – three phase unbalanced and distorted source supplying non-linear loads – concept of power factor – three phase- three wire – three phase - four wire system.

UNIT III MITIGATION OF POWER SYSTEM HARMONICS 9

Introduction - Principle of Harmonic Filters – Series-Tuned Filters – Double Band-Pass Filters – damped Filters – Detuned Filters – Active Filters – Power Converters – Harmonic Filter Design – Tuned Filter – Second-Order Damped Filter – Impedance Plots for Filter Banks – Impedance Plots for a Three-Branch 33 kV Filter.

UNIT IV LOAD COMPENSATION USING DSTATCOM 9

Compensating single – phase loads – Ideal three phase shunt compensator structure – generating reference currents using instantaneous PQ theory – Instantaneous symmetrical components theory – Generating reference currents when the source is unbalanced –Realization and control of DSTATCOM – DSTATCOM in Voltage control mode.

UNITV SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM 9

Rectifier supported DVR – DC Capacitor supported DVR – DVR Structure – Voltage Restoration – Series Active Filter – Unified Power Quality Conditioner.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Use various definitions of power quality for power quality issues
CO2:	Describe the concepts related with single phase / three phase
CO3:	Solve problems related with mitigation of Power System Harmonics
CO4:	Use DSTATCOM for load compensation
CO5:	Demonstrate the role of DVR, SAFs UPQC in power distribution systems
CO6:	Describe the concepts related with linear/nonlinear loads and single phase/three phase

TEXT BOOKS:

1. Arindam Ghosh and GeradLedwich "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers, First Edition,2002
2. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, Second Edition, 2011.
3. George J. Wakileh, "Power System Harmonics – Fundamentals, Analysis and Filter Design", Springer – Verlag Berlin Heidelberg, New York, 2019.

REFERENCE BOOKS:

1. R.C.Duggan "Electric Power Systems Quality", Tata MC Graw Hill Publishers, Third Edition, 2012.
2. Arrillga "Power System Harmonics", John Wiely and Sons, 2003 2nd Edition.
3. Derek A.Paice "Power Electronic Converter Harmonics" IEEE Press, 1995, Wiley – IEE Press 1999, 18th Edition.

U23EEV12	RESTRUCTURED POWER SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To learn the basics of Power Systems restructure models.
2. To understand the scenario of electric utility markets.
3. To understand and analyze the Electric Energy Trading
4. To know concept of open access same-time information system
5. To learn the concepts electricity pricing.

UNIT I OVERVIEW OF ELECTRIC UTILITIES RESTRUCTURING 9

Introduction – Restructuring Models – Independent System Operator (ISO) – Power Exchange (PX) – Market Clearing Price (MCP) –Market Operations – Locational marginal price (LMP) – Market Power-Stranded Costs – Transmission Pricing – Congestion Pricing –Management of Inter-Zonal/Intrazonal Congestion

UNIT II ELECTRIC UTILITY MARKETS AROUND THE WORLD 9

California Markets – New York Market – PJM Interconnection – ERCOT ISO – New England ISO – Midwest ISO – Nord Pool (The Nordic Power Exchange) – Australia National Electricity Market – Restructuring In Canada – Electricity Industry in England and Wales

UNIT III OASIS: OPEN ACCESS SAME-TIME INFORMATION SYSTEM 9

Introduction – FERC Order – Structure of OASIS – Implementation of OASIS Phases – Posting of Information – Transfer Capability on OASIS –Transmission Services – Methodologies to Calculate ATC – Experiences with OASIS in Some Restructuring Models

UNIT IV ELECTRICITY PRICING 9

Introduction – Electricity price Volatility – Electricity Price Indices – Challenges to Electricity Pricing – Construction of forward pricing curves – Short term price forecasting Wheeling cost

UNITV ELECTRIC ENERGY TRADING 9

Introduction – Essence of Electric Energy Trading – Energy Trading Framework: The Qualifying Factors – Derivative Instruments of Energy Trading – Portfolio Management – Energy Trading Hubs – Brokers in Electricity Trading – Green Power Trading.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Explain the key issues in electric utilities restructuring
CO2:	discuss the concept of electric utility markets in the united states & outside the united states
CO3:	discuss the concept of open access same-time information system
CO4:	describe the concept of Electricity Pricing
CO5:	describe the concept of Electric Energy trading
CO6:	Discuss the factors about electric energy trading

TEXT BOOKS:

1. Mohammad Shahidehpour & Muwaffaq Alomoush, "Restructured Electrical Power Systems: Operation, Trading and Volatility", 1st Edition, Taylor & Francis, New York, 2017.
2. Loi Lei Lai ,"Power System Restructuring and Deregulation", 1st Edition, John Wiley and Sons, New York, 2018.

REFERENCE BOOKS:

1. Mohammad Shahidehpour, HatimYamin & Zuyi Li, "Market Operations in Electric Power Systems", 1st Edition, John Wiley and Sons, New York, 2015.

U23EEV13	ENERGY MANAGEMENT AND AUDITING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To study the concepts behind economic analysis and Load management.
2. To understand the basics of materials and energy balance
3. To analyze the energy efficiency in thermal utilities.
4. To know the concept of compressed air system.
5. To illustrate the concept of lighting systems and cogeneration

UNIT I GENERAL ASPECTS OF ENERGY MANAGEMENT AND 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.

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.

UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES 9

Introduction to fuels - properties of fuel oil, coal and gas - principles of combustion - combustion of oil, coal and gas - Boilers: Types, combustion in boilers, performances evaluation, analysis of losses - energy conservation opportunities - FBC boilers.

UNIT IV ENERGY EFFICIENCY IN COMPRESSED AIR SYSTEM 9

Compressed Air System: Types of air compressors - efficient compressor operation - Compressed air system components - leakage test - savings opportunities - Refrigeration System: Vapour compression refrigeration cycle – refrigerants - coefficient of performance - factors affecting Refrigeration and Air conditioning system - savings opportunities.

UNITV ENERGY EFFICIENCY IN 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 - Electric motors: Types - losses in induction motors - motor efficiency - factors affecting motor performance - rewinding and motor replacement issues - energy saving opportunities with energy efficient motor.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Students able to acquire knowledge in the field of energy management and auditing process.
CO2:	Learned the about basic concepts of economic analysis and load management.
CO3:	Able to design the effective thermal utility system.
CO4:	Able to improve the efficiency in compressed air system.
CO5:	Acquired the design concepts in the field of lighting systems.

CO6: Acquired the design concepts in the field of light sources and various forms of cogeneration.

TEXT BOOKS:

1. Mehmet Kanoglu, Yunus A Cengel, "Energy Efficiency and Management for Engineers", McGraw-Hill Education, First Edition, 2020.
2. MoncefKrati, 'Energy Audit of Building Systems: An Engineering Approach', Third Edition,CRC Press, Dec.2020.

REFERENCE BOOKS:

1. Sonal Desai, 'Handbook of Energy Audit', McGraw Hill Education (India) Private Limited,2015.
2. Michael P.Deru, Jim Kelsey, 'Procedures for Commercial Building Energy Audits', American Society of Heating, Refrigerating and Air conditioning Engineers, 2011
3. Thomas D.Eastop, 'Energy Efficiency: For Engineers and Technologists', Longman Scientific & Technical, 1990, 1st Edition.
4. Energy Managers and Energy Auditors Guide book', Bureau of Energy Efficiency, 2006.
5. Larry C. Witte, Philip S.Schmidt, David R.Brown, 'Industrial Energy Management and Utilization', Springer Berlin Heidelberg, 1988.

		L	T	P	C
U23EEV14	**ELECTRICAL ENERGY UTILIZATION AND CONSERVATION**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To know various electric drives and traction motors with applications
2. roduce the energy saving concept by different ways of illumination.
3. To understand the different methods of electric heating and electric welding.
4. To know the conversion of solar and wind energies into electrical energy for different applications.
5. To study the domestic utilization 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)

UNITV DOMESTIC UTILIZATION OF ELECTRICAL ENERGY 9

House wiring - working principle of air conditioning system, Induction based appliances, Online and OFF line UPS, Batteries - Power quality aspects – nonlinear and domestic loads – Earthing system for Domestic, Industrial and Substation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Ability to choose suitable electric drives for different applications
CO2:	Ability to design the illumination systems for energy saving
CO3:	Ability to demonstrate the utilization of electrical energy for heating and welding purposes
CO4:	Ability to know the effective usage of solar and wind energies for electrical applications
CO5:	Ability to do electric connection for any domestic appliances
CO6:	Ability to know earthing system for domestic purpose.

TEXT BOOKS:

1. N.V. Suryanarayana, "Utilisation of Electric Power", Wiley Eastern Limited, New Age International Limited, 1994 & Second Edition 2017 Feb.
2. J.B.Gupta, "Utilisation Electric power and Electric Traction", S.K.Kataria and sons, 2000 2012th Edition, 2013, January.
3. G.D.Rai,"Non-Conventional Energy sources",Khanna publications Ltd.,New Delhi 2017.
4. D.P.Kothari, K.C.Singal, Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI Learing Private Limited, 3rd Edition 2022.
5. Industrial Energy Conservation, Volume I-II, S C Bhatia, Sarvesh Devraj, Energy conservation and Managment by Akshay A pujara1st edition, June 2018.

REFERENCE BOOKS:

1. R.K.Rajput, Utilisation of Electric Power, Laxmi publications 2nd Edition 2016.
2. H.Partab, Art and Science of Utilisation of Electrical Energy", Edition, Dhanpat Rai and Co., New Delhi-2017.
3. C.L.Wadhwa, "Generation, Distribution and Utilisation of Electrical Energy", New Age international Pvt.Ltd., 3rd Edition, 2015 January.

U23EEV15	POWER PLANT INSTRUMENTATION AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To know different methods of power generation with a particular stress on thermal power generation.
2. To know various measurements involved in power generation plants.
3. To know different types of devices used for analysis in power generation plants.
4. To know different types of controls and control loops in boiler.
5. To know methods of monitoring different parameters like speed, vibration of turbines and their control.

UNIT I OVERVIEW OF POWER GENERATION 9

Brief survey of methods of power generation – hydro, thermal, nuclear, solar and wind power – importance of instrumentation in power generation – thermal power plants – building blocks – details of boiler processes – P&I diagram of boiler – cogeneration.

UNIT II MEASUREMENTS IN POWER PLANTS 9

Electrical measurements – current, voltage, power, frequency, power factor etc. – non electrical parameters – flow of feed water, fuel, air and steam with correction factor for temperature – steam pressure and steam temperature – drum level measurement – radiation detector – smoke density measurement – dust monitor.

UNIT III ANALYZERS IN POWER PLANTS 9

Flue gas oxygen analyzer – analysis of impurities in feed water and steam – dissolved oxygen analyzer – chromatography – PH meter – fuel analyzer – pollution monitoring instruments.

UNIT IV CONTROL LOOPS IN BOILER 9

Combustion control – air/fuel ratio control – furnace draft control – drum level control – main steam and reheat steam temperature control – super heater control – at temperature – deaerator control – distributed control system in power plants.

UNITV TURBINE – MONITORING AND CONTROL 9

Speed, vibration, shell temperature monitoring and control – steam pressure control – lubricant oil temperature control – cooling system- Green energy, Hydrogen & fuel cell.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Understand the basic principles of power generation.
CO2: Learn about measurement of various parameters in power plant.
CO3: Know the various analyzers in power plant.
CO4: Understand about the turbine boiler control.
CO5: Explain about the turbine monitoring.
CO6: Learn about air/fuel ratio control in boilers.

TEXT BOOKS:

1. Sam G. Dukelow, “The control of Boilers”, instrument Society of America, 1991.
2. Liptak B.G., “Instrumentation in Process Industries”, Chilton, 1973
3. P.Tamilmani, “Power Plant Instrumentation”, SamsPublishers,Chennai.
4. P.K.Nag, “Power Plant Engineering”, Tata McGraw-Hill Education, 3rd edition, 2007.
5. Krishnaswamy.K and Ponnibala.M., “Power Plant Instrumentation”, PHI Learning Pvt.Ltd., New Delhi, 2011.

REFERENCE BOOKS:

1. Elonka,S.M.andKohal A.L. “Standard Boiler Operations”, McGraw Hill, New Delhi, 1994.
2. R.K.Jain, “Mechanical and industrial Measurements”, Khanna Publishers, New Delhi, 1995.
3. Everett Woodruff , Herbert Lammers, Thomas Lammers, “Steam Plant Operation”, 9th Edition McGraw Hill, 2012.
4. Rajput R.K., “A Text book of Power plant Engineering”, 5th Edition, Lakshmi Publications, 2013.
5. E.Al. Wakil, “Power Plant Engineering”, Tata McGraw Hill, 1984.

U23EEV16	MICRO GRIDS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To impart knowledge about distributed generation technologies, their interconnection in grid
2. To understand relevance of power electronics in DG
3. To understand concept of microgrid
4. To know various impacts of grid integration
5. To study the control and operation of microgrid

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.

UNIT II DISTRIBUTED GENERATIONS (DG) 9

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

UNIT III IMPACT OF GRID INTEGRATION 9

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

UNIT IV BASICS OF A MICROGRID 9

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

UNITV 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.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Relate the conventional power generation and distributed generation
CO2: Analyze the concept of distributed generation and installation
CO3: Explain the grid integration system with conventional and non-conventional energy sources
CO4: Explicate the concept of AC/DC microgrids
CO5: Analyze power quality issues and control operation of micro grid
CO6: Analyse the passive and active based tecniques

TEXT BOOKS:

1. Nikos Hatziargyriou, "Microgrids: Architectures and Control", December 2013, Wiley-IEEE Press.
2. S. Chowdhury, S.P. Chowdhury and P. Crossley, "Microgrids and Active Distribution Networks", The Institution of Engineering and Technology, London, U.K, 2009.

REFERENCE BOOKS:

1. AmirnaserYezdani, and Reza Iravani, "Voltage Source Converters in Power Systems: Modeling, Control and Applications", IEEE John Wiley Publications, 2009.
2. DorinNeacsu, "Power Switching Converters: Medium and High Power", CRC Press, Taylor & Francis, 2006.
3. Chetan Singh Solanki, "Solar Photo Voltaics", , PHI learning Pvt. Ltd., New Delhi, 2009
4. J.F. Manwell, J.G "Wind Energy Explained, Theory Design and Applications,". McGowan Wiley publication, 2nd Edition, 2009.
5. D. D. Hall and R. P. Grover, "Biomass Regenerable Energy", , John Wiley, New York, 1987.
6. John Twidell and Tony Weir, "Renewable Energy Resources", Taylor and Francis Publications, Second Edition, 2006.

VERTICAL II EMBEDDED AND AUTOMATION CONTROL

U23EEV21	EMBEDDED SYSTEM DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students :

1. To introduce the Building Blocks of an embedded System and Software Tools
2. To emphasize the role of Input/output interfacing with Bus Communication protocol.
3. To illustrate the ISR and scheduling for the multitasking process.
4. To explain the basics of a Real-time operating system
5. To analyze the applications based on embedded design approaches

UNIT I INTRODUCTION TO EMBEDDED SYSTEMS 9

Introduction to Embedded Systems –Structural units in Embedded processor, selection ofprocessor & memory devices- DMA — Memory management methods- Timer and Countingdevices, Real Time Clock, In-circuit emulator, Target Hardware Debugging.

UNIT II EMBEDDED NETWORKING 9

Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communicationprotocols RS232 standard – RS485 – CAN Bus- Serial Peripheral Interface (SPI) – Inter-Integrated Circuits (I2C).

UNIT III INTERRUPTS THE SERVICE MECHANISM AND DEVICE DRIVER 9

Programmed-I/O busy-wait approach without interrupt service mechanism-ISR concept-interruptsources – multiple interrupts – context and periods for context switching, interrupt latency anddeadline – Introduction to Device Drivers.

UNIT IV RTOS-BASED EMBEDDED SYSTEM DESIGN 9

Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS,Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication- shared memory, message passing- Inter-process Communication - Introduction to process synchronization using semaphores.

UNITV EMBEDDED SYSTEM APPLICATION DEVELOPMENT 9

Embedded Product Development Life Cycle - Case Study: Precision Agriculture- Autonomous car.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	The hardware functionals and software strategies required to develop various Embedded systems
CO2:	The basic differences between various Bus communication standards
CO3:	The incorporation of the interface as Interrupt services
CO4:	The various scheduling algorithms through a Real-time operating system.
CO5:	The various embedded concepts for developing automation applications.
CO6:	The basic function of synchronization using semaphores.

TEXT BOOKS:

1. Rajkamal, 'Embedded system-Architecture, Programming, Design, McGraw-Hill Edu, 3rd edition 2017.
2. Peckol, "Embedded system Design", John Wiley & Sons,2010.

REFERENCE BOOKS:

1. Shibu. K.V, "Introduction to Embedded Systems", TataMcgraw Hill, 2nd edition 2017.
2. LyaB.Das," Embedded Systems" ,Pearson Education, 1st edition 2012.
3. Parag H.Dave,HimanshuB.Dave," Embedded Systems-Concepts ,Design and Programming, Pearson Education,2015, 1st edition.
4. Elicia White, "Making Embedded systems", O'Reilly Series ,SPD,2011, 1st edition.
5. Jonathan W. Valvano, 'Embedded Microcomputer Systems Real-time Interfacing', Cengage Learning , 3rd edition 2010.
6. Tammy Noergaard, "Embedded Systems Architecture", Newnes, 2nd edition, 2013.

U23EEV22	SMART SYSTEM AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students :

1. To explain the smart system technologies and its role in real time applications
2. To understand the architecture and requirements of Home Automation.
3. To illustrate an insight into smart appliances and energy management concepts.
4. To familiarize the design and needs of smart wearable devices
5. To explain the basics of robotics and its role for automation.

UNIT I INTRODUCTION 9

Overview of a smart system - Hardware and software selection - Smart sensors and Actuators – Communication protocols used for smart systems.

UNIT II HOME AUTOMATION 9

Home Automation – System Architecture - Essential Components- Design Considerations: ControlUnit, Sensing Requirements, Communication, Data Security.

UNIT III SMART APPLIANCES AND ENERGY MANAGEMENT 9

Significance of smart appliances for energy management -Smart Meters: Significance, Architecture& Energy Measurement Technique – Security Considerations.

UNIT IV SMART WEARABLE DEVICES 9

Body Area Networks - Sensors– communication protocol for Wearable devices- Application of Smart Wearable in Healthcare & Activity Monitoring.

UNITV EMBEDDED SYSTEMS AND ROBOTICS 9

Fundamental concepts in Robotics- Robots and Controllers components - Embedded processor based: pick and place robot- Mobile Robot Design- UAV.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Understand the concepts of smart system design and its present developments.
CO2:	Illustrate different embedded open-source and cost-effective techniques for developing.
CO3:	Acquire knowledge on different platforms and Infrastructure for Smart system design.
CO4:	Infer about smart appliances and energy management concepts.
CO5:	Improve Employability and entrepreneurship capacity due to knowledge upgradation on embedded system technologies.
CO6:	Develop the mobile robot design.

TEXT BOOKS:

1. Grimm, Christoph, Neumann, Peter, Mahlknech and Stefan, Embedded Systems for Smart Appliances and Energy Management, Springer 2013, 1st Edition.
2. KazemSohraby, Daniel Minoli and TaiebZnati, Wireless Sensor Networks Technology, Protocols, and Applications, John Wiley & Sons, 2007, 1st Edition.
3. NilanjanDey, Amartya Mukherjee, Embedded Systems and Robotics with Open-Source Tools, CRC press, 2016, 1st Edition.

REFERENCE BOOKS:

1. Thomas Bräunl, Embedded Robotics, Springer, 2003.
2. Raj Kamal, Embedded Systems - Architecture, Programming and Design, McGraw- Hill, 2008
3. Karim Yaghmour, Embedded Android, O'Reilly, 2013.
4. Steven Goodwin, Smart Home Automation with Linux and Raspberry Pi, Apress , 2013
5 C.K. Toh, AdHoc mobile wireless networks, Prentice Hall, Inc, 2002.
6 Anna Ha´c, Wireless Sensor Network Designs, John Wiley & Sons Ltd, 2003.
7 J. J. Craig, "Introduction to Robotics Mechanics and Control", Pearson Education.
8 Y. Koren, "Robotics for Engineers", McGraw-Hill.
9 Robert Faludi, Wireless Sensor Networks, O'Reilly, 2011.

U23EEV23	MEMS AND NEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students :

1. To introduce the diverse technological and functional approaches of MEMS/NEMSand applications.
2. To understand the microstructures and fabrication methods.
3. To provide an insight of micro and nano sensors, actuators.
4. To emphasise the need for NEMS technology.
5. To update the ongoing trends and real time applications of MEMS and NEMStechnology.

UNIT I INTRODUCTION TO MEMS and NEMS 9

Overview of Micro electro mechanical systems and Nano Electro mechanical systems, devices andtechnologies, Laws of scaling- Materials for MEMS and NEMS - Applications of MEMS andNEMS.

UNIT II MICRO-MACHINING AND MICROFABRICATION TECHNIQUES 9

Photolithography- Micro manufacturing, Bulk micro machining, surface micro machining, LIGA.

UNIT III MICRO SENSORS AND MICRO ACTUATORS 9

Micromachining:Capacitive Sensors- Piezo-resistive Sensors- Piezoelectric actuators.

UNIT IV NEMS TECHNOLOGY 9

Atomic scale precision engineering- Nano Fabrication techniques – NEMS for sensors and actuators.

UNITV MEMS and NEMS APPLICATION 9

Bio MEMS- Optical NEMS- Micro motors- Smart Sensors - Recent trends in MEMS and NEMS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Explain the material properties and the significance of MEMS and NEMS for industrial automation.
CO2:	Demonstrate knowledge delivery on micromachining and micro fabrication.
CO3:	Apply the fabrication mechanism for MEMS sensor and actuators.
CO4:	Apply the concepts of MEMS and NEMS to models,simulate and process the sensors and actuators.
CO5:	Improved Employability and entrepreneurship capacity due to knowledge up gradation on MEMS and NEMS technology.
CO6:	Developments in recent trends in MEMS.

TEXT BOOKS:

1. Chang Liu, “Foundations of MEMS”, Pearson International Edition, 2011, 2nd Edition.
2. Tai-.Ran Hsu, “MEMS and Microsystems: design, manufacture, and Nanoscale”- 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.
3. Lyshevski, S.E. “ Nano- and Micro-Electromechanical Systems: Fundamentals of Nano-and Microengineering “ (2nd ed.). CRC Press,2005.
4. Julian W Gardner and Vijay K Varadan, “ Microsensors, MEMS and Smart Devices”, John Wileyand Sons Ltd, 2001, 1st Edition.

REFERENCE BOOKS:

1. Amirnaser Yezdani, and Reza Iravani, "Voltage Source Converters in Power Systems: Modeling, Control and Applications", IEEE John Wiley Publications, 2009.
2. DorinNeacsu, "Power Switching Converters: Medium and High Power", CRC Press, Taylor & Francis, 2006.
3. Chetan Singh Solanki, "Solar Photo Voltaics", , PHI learning Pvt. Ltd., New Delhi, 2009
4. J.F. Manwell, J.G "Wind Energy Explained, Theory Design and Applications,". McGowan Wiley publication, 2nd Edition, 2009.
5. D. D. Hall and R. P. Grover, "Biomass Regenerable Energy", , John Wiley, New York, 1987.
6. John Twidell and Tony Weir, "Renewable Energy Resources", Taylor and Francis Publications, Second Edition, 2006.

U23ECO13	VLSI DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To explain the basic concepts of CMOS and
2. To describe the IC fabrication methods
3. To understand the Reconfigurable Processor technologies
4. To illustrate the basics of analog VLSI design and its importance.
5. To learn about the programming of Programmable device using Hardware descriptionLanguage.

UNIT I ICMOS BASICS 9

MOSFET Scaling - CMOS logic design- Dynamic CMOS –Transmission Gates- BiCMOS

UNIT II IC FABRICATION 9

CMOS IC Fabrications: n well, p well, twin tub, SoI - Design Rules and Layout.

UNIT III PROGRAMABLE LOGIC DEVICES 9

PAL, PLA, CPLD architecture and application.

UNIT IV RECONFIGURABLE PROCESSOR 9

FPGA- Architecture, FPGA based application development- Introduction to FPAA.

UNITV HDL PROGRAMMING 9

Verilog HDL- Overview - structural and behavioural modelling concepts-Design examples- Carry Look ahead adders, ALU, Shift Registers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Develop CMOS design techniques
CO2: Learn and build IC fabrication
CO3: Explain the need of reconfigurable computing with PLDs.
CO4: Design and development of reprogrammable FPGA.
CO5: Illustrate and develop HDL computational processes with improved design strategies.
CO6: Learn about shift registers.

TEXT BOOKS:

1. M.J.S Smith, “Application Specific integrated circuits”,Addition Wesley Longman Inc. 1st Edition 2010.
2. Kamran Eshraghian,DouglasA.pucknell and SholehEshraghian,”Essentials of VLSI circuits andsystem”, Prentice Hall India,2005, 1st Edition.

REFERENCE BOOKS:

1. Donald G. Givone, “Digital principles and Design”, Tata McGraw Hill 2002, 1st Edition.
2. Charles H. Roth Jr., “Fundamentals of Logic design”, Thomson Learning, 7th Edition 2013.
3. Nurmi, Jari (Ed.) "Processor Design System-On-Chip Computing for ASICs and FPGAs" Springer, 2007, 1st Edition.
4. Joao Cardoso, Michael Hübner, "Reconfigurable Computing: From FPGAs to Hardware/Software Codesign" Springer, 2011, 1st Edition.
5. Pierre-Emmanuel Gaillardon, Reconfigurable Logic: Architecture, Tools, and Applications,

U23EEV25	EMBEDDED CONTROL FOR ELECTRIC DRIVES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students :

1. To understand the control concept for electrical drives
2. To emphasize the need of embedded systems for controlling the electrical drives
3. To explain about various embedded system-based control strategies for electrical drives
4. To understand optimization and machine learning techniques used for electrical drives
5. To familiarize the high-performance computing for electrical drives.

UNIT I INTRODUCTION TO ELECTRIC DRIVES 9

Electric drives and its classification-Four-quadrant drive-Solid State Controlled Drives-Machine Learning and optimization techniques for electrical drives.

UNIT II EMBEDDED SYSTEM FOR MOTOR CONTROL 9

Embedded Processors choice for motor control- Sensors and interface modules for Electric drives-IoT for Electrical drives applications.

UNIT III INDUCTION MOTOR CONTROL 9

Speed control methods-PWM techniques- VSI fed three-phase induction motor- Fuzzy logic Basedspeed control for three-phase induction motor- Embedded processor based three phase inductionmotor speed control.

UNIT IV BLDC MOTOR CONTROL 9

Overview of BLDC Motor -Speed control methods -PWM techniques- Embedded processor basedBDLC motor speed control.

UNITV SRM MOTOR CONTROL 9

Overview of SRM Motor -Speed control methods -PWM techniques- Embedded processor based SRM motor speed control.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Interpret the significance of embedded control of electrical drives

CO2: Deliver insight into various control strategies for electrical drives.

CO3: Developing knowledge of Machine learning and optimization techniques for motor control.

CO4: Develop embedded system solutions for real-time application such as Electric vehicles and UAVs

CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded system skills required for motor control strategy.

CO6: Develop embedded based motor speed control.

TEXT BOOKS:

1. R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”,Prentice-Hall of India Pvt. Ltd., New Delhi,2010, 1st Edition.
2. Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization" Willey, 2007, 1st Edition.

REFERENCE BOOKS:

1. 1. VedamSubramanyam, “Electric Drives – Concepts and Applications”, Tata McGraw- Hill publishing company Ltd., New Delhi, 2002, 2nd Edition.
2. K. Venkataratnam ,Special Electrical Machines, Universities Press, 2014, 1st Edition.
3. Steve Furber, ‘ARM system on chip architecture’, Addision Wesley, 2nd Edition 2015.
4. Ron Sass and AnderewG.Schmidt, “ Embedded System design with platform FPGAs: Principles and Practices”, Elsevier, 2010, 1st Edition.
5. Tim Wescott , Applied Control Theory for Embedded Systems , Elsevier, 2006, 1st Edition.

U23EEV26	SCADA AND DISTRIBUTD CONTROL SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students :

1. To learn the Components of SCADA and DCS.
2. To understand the Architecture of DCS.
3. To learn the Information about the programming languages and the interfaces used in DCS and Computer Controlled Systems.
4. To learn the Components of SCADA and DCS.
5. To learn the applications of SCADA and DCS.

UNIT I INTRODUCTION TO COMPUTER CONTROLLED SYSTEMS 9

Introduction– Principles of modern Supervisory Control systems- Computer in process control – Building blocks of Computer controlled systems–Supervisory Control – Direct digital Control, Man-machine interface – Management Information System.

UNIT II ELEMENTS OF SCADA SYSTEMS 9

Data Acquisition System –Data storage with time stampings – SCADA - Hardware and software, Remote terminal units, Master Station and Communication architectures.

UNIT III DISTRIBUTED CONTROL SYSTEM & INTERFACES 9

Distributed Control System – Various Architectures – Comparison – Local control unit – Process interfacing issues – Communication facilities in DCS. Operator interfaces:- Low level and high level operator interfaces – Displays - Engineering interfaces : Low level and high level engineering interfaces.

UNIT IV HART AND FIELD BUS 9

Introduction – Evolution of Signal standard – HART Communication Protocol – Communication Modes – HART Commands – HART Applications Field Bus-Introduction, General field bus Architecture, Basic requirements of Field bus standard, Field Bus topology.

UNITV APPLICATIONS OF SCADA & DCS IN INDUSTRIES 9

Applications of SCADA & DCS in Thermal power plant, Cement manufacturing Industries, Sugar Industries, paper manufacturing Industries and Water Treatment plant.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Interface DCS system in different architecture.
CO2: Interface DCS system in different standards
CO3: Interface the digital controllers with PC.
CO4: Identify required architectural interface for the industrial process.
CO5: Develop simple proto type applications.
CO6: Develop the water treatment plant.

TEXT BOOKS:

1. Krishna kant, “Computer based industrial control”, PHI, second edition, 2010.
2. Stuart G McCrady, “Designing SCADA Application Software: A Practical Approach”, First Edition, Elsevier, 30-Jul-2013.

REFERENCE BOOKS:

1. Clarke, G., Reynders, D. and Wright, E., "Practical Modern SCADA Protocols: "DNP3, 60870.5 and Related Systems", Newnes, 1st Edition, 2004.
2. Gordon Clarke, Deon Reynders, "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Elsevier, 20-Jan-2004.
3. David Bailey & Edwin Wright, "Practical SCADA for Industry", Elsevier 2003.
4. Michael P. Lukas, "Distributed Control System", Van Nostrand Reinhold Co., Canada, 1995.

VERTICAL III ELECTRIC VEHICLE TECHNOLOGY

U23EEV31	ELECTRIC VEHICLE ARCHITECTURE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To learn the structure of Electric Vehicle, Hybrid Electric Vehicle
2. To study about the EV conversion components
3. To know about the details and specifications for Electric Vehicles
4. To understand the concepts of Plug-in Hybrid Electric Vehicle
5. To model and simulate all types of DC motors

UNIT I VEHICLE ARCHITECTURE & SIZING 9

Electric Vehicle History, and Evolution of Electric Vehicles. Series, Parallel and Series parallel Architecture, Micro and Mild architectures. Mountain Bike - Motorcycle- Electric Cars and Heavy DutyEVs. -Details and Specifications.

UNIT II VEHICLE MECHANICS 9

Vehicle mechanics- Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire –Road mechanics, Propulsion System Design.

UNIT III POWER COMPONENTS AND BRAKES 9

Power train Component sizing- Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Power train sizing, Example.

UNIT IV HYBRID VEHICLE CONTROL STRATEGY 9

Vehicle supervisory control, Mode selection strategy, Modal Control strategies

UNITV PLUG-IN HYBRID ELECTRIC VEHICLE 9

Introduction - History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging mechanisms-Advantages of PHEVs.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Summarize the History and Evolution of EVs, Hybrid and Plug-In Hybrid EVs
CO2: Describe the various EV components
CO3: Describe the concepts related in the Plug-In Hybrid Electric Vehicles
CO4: Analyse the details and Specifications for the various EVs developed
CO5: Describe the hybrid vehicle control strategy.
CO6: Analyse the power components and brakes

TEXT BOOKS:

1. Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.

2. The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and Bicycles -- Includes EV Components, Kits, and Project Vehicles Mark Warner, HP Books, 2011

REFERENCE BOOKS:

1. Build Your Own Electric Vehicle,Seth Leitman , Bob Brant, McGraw Hill, Third Edition 2013.
2. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, First edition 2017.
3. Heavy-duty Electric Vehicles from Concept to Reality, Shashank Arora, Alireza Tashakori Abkenar, Shantha Gamini Jayasinghe, Kari Tammi, Elsevier Science, 2021
4. Electric Vehicles Modern Technologies and Trends, Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen Springer, 2020
5. Hybrid Electric Vehicles: A Review of Existing Configurations and Thermodynamic Cycles, Rogelio León , Christian Montaleza , José Luis Maldonado , Marcos Tostado-Véliz and Francisco Jurado, Thermo, 2021, 1, 134–150. https://doi.org/10.3390/thermo1020010

U23EEV32	DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To review the drive cycles and requirements of EVs
2. To know the working of motors used in Electric Vehicle
3. To analyze and model the buck/boost converter operation and to design the same
4. To learn the simulation basics of control systems
5. To derive transfer functions for DC-DC converters.

UNIT I ELECTRIC VEHICLE DYNAMICS 9

Standard drive cycles-Dynamics of Electric Vehicles-Tractive force-Maximum speed, torque, power, energy requirements of EVs.

UNIT II MOTORS FOR ELECTRIC VEHICLES 9

Introduction – Speed And Torque control of above and below rated speed-Speed control of EV in the constant power region of electric motors. DC Motors, Induction Motor, Permanent Magnet Synchronous Motors (PMSM), Brushless DC Motors, Switched Reluctance Motors (SRMs). Synchronous Reluctance Machines-Choice of electric machines for EVs

UNIT III BASICS OF SIMULATION IN CONTROL SYSTEMS 9

Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots, bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state space modelling-transfer function from state space Model.

UNIT IV MODELING OF DC-DC CONVERTERS 9

Overview of PWM Converter Modelling -Power Stage Modelling - PWM Block Modelling - Voltage Feedback Circuit and Small-Signal Model of PWM Converter - Averaging Power Stage Dynamics - Average Models for buck/boost Converter - Small-Signal Model of Converter Power Stage - Frequency Response of Converter

UNITV POWER STAGE TRANSFER FUNCTIONS 9

Rectifier supported DVR – DC Capacitor supported DVR – DVR Structure – Voltage Restoration – Series Active Filter – Unified Power Quality Conditioner.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	To use appropriate electric machine for electric vehicle application
CO2:	To compute transfer function with factors such as constant, integral, differential, first order factor and second order factor (both numerators & denominators)
CO3:	To compute transfer function from state models.
CO4:	To design buck, boost and buck-boost converter.
CO5:	To compute a power stage transfer functions for DC-DC converters.
CO6:	Analyse the various power stage transfer functions

TEXT BOOKS:

1. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition 2017.

2. Emerging Power Converters for Renewable Energy and Electric Vehicles Modeling, Design, and Control, Md. Rabiul IslamMd. Rakibuzzaman Shah, Mohd. Hasan Ali, CRC Press,2021,1st Edition.

REFERENCE BOOKS:

1. Fundamentals of Power Electronics with MATLAB, Randall Shaffer, 2nd Edition, 2013, Lakshmipublications
2. Feedback Control problems using MATLAB and the Control system tool box, Dean Frederick and Joe Cho, 2000, 1st Edition, Cengage learning.
3. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis,2005,1st Edition.
4. Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley,2021, 1st Edition.
5. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals, Second Edition” CRC Press, Taylor & Francis Group, Third Edition 2021.

U23EEV33	INTELLIGENT CONTROL OF ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To design and drive the mathematical model of a BLDC motor and its characteristics
2. To learn the different control schemes for BLDC motor
3. To study the basics of fuzzy logic
4. To study the FPGA & VHDL basics
5. To implement fuzzy logic control of BLDC motor in real time

UNIT I MATHEMATICAL MODEL AND CHARACTERISTICS ANALYSIS OF THE BLDC MOTOR 9

Structure and Drive Modes - Basic Structure, General Design Method, Drive Modes. Mathematical Model, Differential Equations, Transfer Functions, State-Space Equations. Characteristics Analysis, Starting Characteristics, Steady-State Operation, Dynamic Characteristics, Load Matching Commutation Transients

UNIT II SPEED CONTROL FOR ELECTRIC DRIVES 9

Introduction -PID Control Principle, Anti windup Controller, Intelligent Controller. Vector Control.Control applied to BLDC motor.

UNIT III FUZZY LOGIC 9

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

UNIT IV FPGA AND VHDL BASICS 9

Introduction – FPGA Architecture-Advantages-Review of FPGA family processors- Spartan 3, Spartan 6 and Spartan 7. VHDL Basics- Fundamentals-Instruction set-data type-conditional statements- programs like arithmetic, sorting, PWM generation, Speed detection.

UNITV REAL TIME IMPLEMENTATION 9

Inverter design, identifying rotor position via hall effect sensors, open loop and fuzzy logic control of 48 V BLDC motor using FPGA.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	To design the mathematical model of a BLDC motor and to discuss about its characteristics.
CO2:	To demonstrate the PID control, ant windup controller, Intelligent Controller
CO3:	To illustrate the basics of fuzzy logic system168.
CO4:	To describe the basics of VHDL & FPGA applied to control of EVs.
CO5:	To design and implement of fuzzy logic control scheme for BLDC motor using FPGA in real Time.
CO6:	To demonstrate theVector Control. Control applied to BLDC motor.

TEXT BOOKS:

1. Wei Liu, Hybrid Electric Vehicle System Modelling and Control, Wiley 2017, 2nd Edition.
2. Electric Power train Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, John G. Hayes, G. Abas Goodarzi, Wiley 1st Edition 2018.

REFERENCE BOOKS:

1. VHDL Primer, A (3rd Edition), Jayaram Bhasker, Prentice Hall, 1st Edition 2015.
2. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Third Edition" CRC Press, Taylor & Francis Group, 2021, 1st Edition.
3. Chang-liang, Permanent Magnet Brushless DC Motor Drives and Controls, Xia Wiley 2012, 1st Edition.
4. M.N. Cirstea, A. Dinu, J.G. Khor,M. McCormick, Neural and Fuzzy Logic Control of Drives and Power Systems, Newnes publications, 1st Edition, 2002.
5. Electric and Plug-in Hybrid Vehicle Networks Optimization and Control, Emanuele Crisostomi • Robert Shorten, Sonja Stüdli • Fabian Wirth, CRC Press, 1st Edition. 2018.

U23EEV34	GRID INTEGRATION OF ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To know the basic details of V2G.
2. To study the benefits & challenges of V2G.
3. To learn EV & V2G on the smart grids renewable energy systems.
4. To know the grid integration.
5. To study impact EV & V2G

UNIT I DEFINITION, AND STATUS OF V2G 9

Defining Vehicle to Grid (V2G) - History and Development of V2G. Incorporating V2G to the EV,Auditing and Metering, V2G in Practice, V2G - Power Markets and Applications. Electricity Markets and V2G Suitability, Long-Term Storage, Renewable Energy, and Other Grid Applications, Beyond the Grid: Other Concepts Related to V2G.

UNIT II BENEFITS AND CHALLENGES OF V2G 9

Benefits of V2G, Technical Benefits: Storage Superiority and Grid Efficiency, Economic Benefits: EV Owners and Societal Savings, Environment and Health Benefits: Sustainability in Electricity and Transport, Other Benefits.

UNIT III CHALLENGES TO V2G 9

Technical Challenges-Battery Degradation, Charger Efficiency, Aggregation and Communication, V2G in a Digital Society- The Economic and Business Challenges to V2G - Evaluating V2G Costs and Revenues , EV Costs and Benefits , Adding V2G Costs and Benefits , Additional V2G Costs, The Evolving Nature of V2G Costs and Benefits. Regulatory and Political Challenges to V2G , V2G and Regulatory Frameworks , Market Design Challenges. Other V2G Regulatory and Legal Challenges.

UNIT IV IMPACT OF EV AND V2G ON THE SMART GRID AND RENEWABLE ENERGY SYSTEMS 9

Introduction - Types of Electric Vehicles - Motor Vehicle Ownership and EV Migration - Impact of Estimated EVs on Electrical Network - Impact on Drivers and the Smart Grid - Standardization and Plug-and-Play - IEC 61850 Communication Standard and IEC 61850-7-420 Extension.166

UNITV GRID INTEGRATION AND MANAGEMENT OF EVS 9

Introduction - Machine to Machine (M2M) in distributed energy management systems - M2M communication for EVs - M2M communication architecture (3GPP) - Electric vehicle data logging -Scalability of electric vehicles -M2M communication with scheduling.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Explain the concepts related with V2G.
CO2:	Study the grid connection of 3 phase Q inverter.
CO3:	Explain the technical, economics. business, regulatory
CO4:	Demonstrate the impact of EV and V2G on smart grid and renewable energy system.
CO5:	Explain the concept of grid integration and management of EVs.
CO6:	Explain the political challenges related with V2G.

TEXT BOOKS:

1. Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid, Junwei Lu and Jahangir Hossain,IET 2015, 1st Edition.
2. ICT for Electric Vehicle Integration with the Smart Grid, Nand Kishor 1; Jesus Fraile-Ardanuy, IET 2020, 1st Edition.

REFERENCE BOOKS:

1. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press 2017, 1st Edition.
2. Plug In Electric Vehicles in Smart Grids, Charging Strategies, Sumedha Rajakaruna, Farhad Lance Noel · Gerardo Zarazua de Rubens Johannes Kester · Benjamin K.
3. Sovacool,Vehicleto-Grid A Sociotechnical Transition Beyond Electric Mobility, 2019, 1st Edition.

U23EEV35	DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To know the charging station and standards
2. To learn the concepts of power converters in charging
3. To find the charging scheme in renewable based EV charging
4. To demonstrate the wireless power transfer technique
5. To design & simulate power factor correction circuits

UNIT I CHARGING STATIONS AND STANDARDS 9

Introduction-Charging technologies- Conductive charging, EV charging infrastructure, International standards and regulations - Inductive charging, need for inductive charging of EV, Modes and operating principle, Static and dynamic charging, Bidirectional power flow, International standards and regulations.

UNIT II POWER ELECTRONICS FOR EV CHARGING 9

Layouts of EV Battery Charging Systems-AC charging-DC charging systems- Power Electronic Converters for EV Battery Charging- AC–DC converter with boost PFC circuit, with bridge and without bridge circuit - Bidirectional DC–DC Converters- Non-isolated DC–DC bidirectional converter topologies- Half-bridge bidirectional converter.

UNIT III EV CHARGING USING RENEWABLE AND STORAGE SYSTEMS 9

Introduction- - EV charger topologies , EV charging/discharging strategies - Integration of EV charging-home solar PV system , Operation modes of EVC-HSP system , Control strategy of EVCHSPsystem - fast-charging infrastructure with solar PV and energy storage.

UNIT IV WIRELESS POWER TRANSFER 9

Introduction - Inductive, Magnetic Resonance, Capacitive types. Wireless Chargers for Electric Vehicles - Types of Electric Vehicles - Battery Technology in EVs -Charging Modes in EVs – Benefitsf WPT. - WPT Operation Modes - Standards for EV Wireless Chargers, SAE J2954, IEC 61980. ISO19363

UNITV POWER FACTOR CORRECTION IN CHARGING SYSTEM 9

Need for power factor correction- Boost Converter for Power Factor Correction, Sizing the Boost Inductor, Average Currents in the Rectifier and calculation of power losses.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	To illustrate various charging techniques and to know charging standards and regulations.
CO2 :	To demonstrate the working o DC-DC converters used for charging systems and principles
CO3:	To illustrate the advantages of renewable system based charging systems
CO4:	To demonstrate the principles of wireless power transfer.
CO5:	To analyze the standards for wireless charging
CO6:	Explain the power factor correction in charging system

TEXT BOOKS:

1. Alicia Triviño-Cabrera, José M. González-González, José A. Aguado, Wireless Power Transfer for Electric Vehicles: Foundations and Design Approach, Springer Publisher 1st Edition. 2020.
2. Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control, management and grid integration, Rajiv Singh, Sanjeevikumar Padmanaban, Sanjeet Dwivedi, Marta Molinas and Frede Blaabjerg, IET 2021, 1st Edition.

REFERENCE BOOKS:

1. Mobile Electric Vehicles Online Charging and Discharging, Miao Wang Ran Zhang Xuemin (Sherman) Shen, Springer 2016, 1st Edition.
2. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, Electric Vehicles Modern Technologies and Trends. Springer Publisher 1st Edition, 2021.
3. Electric and Hybrid Electric Vehicles, James D Halderman, Pearson, 2022, 1st Edition.
4. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005.

U23EEV36	ELECTRIC VEHICLE DESIGN, MECHANICS AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To learn the basics of EV and vehicle mechanics
2. To know the EV architecture
3. To study the energy storage system concepts
4. To derive model for batteries and to know the different types of batteries and its charging methods
5. To learn the control preliminaries for DC-DC converters.

UNIT I INTERNAL COMBUSTION ENGINES 9

IC Engines, BMEP and BSFC, Vehicle Fuel Economy, Emission Control Systems, Treatment of Diesel Exhaust Emissions.

UNIT II ELECTRIC VEHICLES AND VEHICLE MECHANICS 9

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings- Comparisons of EV withinternal combustion Engine vehicles- Fundamentals of vehicle mechanics.

UNIT III BATTERY MODELING, TYPES AND CHARGING 9

Batteries in Electric and Hybrid Vehicles - Battery Basics -Battery Parameters. Types- Lead Acid Battery - Nickel-Cadmium Battery - Nickel-Metal-Hydride (NiMH) Battery - Li-Ion Battery - Li-Polymer Battery, Zinc-Air Battery, Sodium-Sulphur Battery, Sodium-Metal-Chloride, Research and Development for Advanced Batteries. Battery Modelling, Electric Circuit Models. Battery Pack Management, Battery Charging.

UNIT IV CONTROL PRELIMINARIES 9

Control Design Preliminaries - Introduction - Transfer Functions – Bode plot analysis for First orderand second order systems - Stability - Transient Performance- Power transfer function for boostconverter - Gain margin and Phase margin study-open loop mode.

UNITV VCONTROL OF AC MACHINES 9

Introduction- Reference frame theory, basics-modeling of induction and synchronous machine in various frames-Vector control- Direct torque control.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	To describe the concepts related with EV, HEV and to compare the same with internal combustion engine vehicles
CO2:	To find gain margin & phase margin for various types of transfer functions of boost converter
CO3:	To demonstrate the Control of A C Machines.
CO4:	To explain the concepts related with batteries and parameters of battery
CO5:	To module the battery and to study the research and development for batteries
CO6:	To understand concept of electric Vehicle

TEXT BOOKS:

1. Electric and Hybrid Vehicles, Design Fundamentals, Third Edition, Iqbal Husain, CRC Press,2021.
2. C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001, 1st Edition.

REFERENCE BOOKS:

1. Power Electronic Converters,: Dynamics and Control in Conventional and Renewable Energy Applications, Teuvo Suntio, Tuomas Messo, Joonas Puukko, 1st Edition, Wiley - VCH.
2. Ali Emadi, Mehrdad Ehsani, John M.Miller, “Vehicular Electric Power Systems”, Special IndianEdition, Marcel dekker, Inc 2003, 1st Edition.
3. Wie Liu, “Hybrid Electric Vehicle System Modeling and Control”, Second Edition, John Wiley &Sons, 2017, 2nd Edition.
4. Dynamic Simulation of Electric Machinery using MATLAB, Chee Mun Ong, Prentice Hall,1997,1st Edition.
5. Electrical Machine Fundamentals with Numerical Simulation using MATLAB/ SIMULINK, AtifIqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley, 2021, 1st Edition.

VERTICAL IV GENERAL

U23AIT41	ARTIFICIAL INTELLIGENCE FOR ENGINEERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To learn about history of AI and symbolic logic in AI
2. To understand the knowledge representation and reasoning mechanisms
3. To study uncertainty and searching techniques to solve real world problems
4. To learn AI technologies and expert systems
5. To introduce machine learning models and AI in various applications

UNIT I INTRODUCTION AND LOGIC 9

Introduction-History of AI-Applications of AI-Future of AI- Logic-Propositions-Normal Forms-Logical consequences-Resolution principle-Predicate calculus- Clausal Form-Rules of Inference-Unification-Resolution .

UNIT II KNOWLEDGE REPRESENTATION AND REASONING 9

Procedure for knowledge acquisition-Knowledge representation-Types of representation schemes-Reasoning-Forward chaining-Backward chaining-Domain modelling-Semantic nets reasoning systems-Frame based systems.

UNIT III UNCERTAINTY AND SEARCH TECHNIQUES 9

Uncertainty-Non monotonic and monotonic reasoning-Bayes theorem-Dempster and Shafer's theory of evidences-Non-classical logics-Default logics-Bayesian networks-Fuzzy logic- Searching-Problem representation-Representation schemes-Blind search techniques-Heuristic search techniques- Game searches.

UNIT IV AI TECHNOLOGIES AND EXPERT SYSTEMS 9

Computer vision- Natural language processing-Speech recognition-Expert systems- Basic characteristics-Brief history-Knowledge Engineering - Inferencing-Programming methodology and Expert systems tools .

UNITV NEURAL NETWORKS AND APPLICATIONS OF AI 9

Introduction - Features of Biological neural networks-Learning algorithms-Different network architecture and their applications-Some simple networks-Comparison of neural networks with rule based networks and expert systems- AI Applications-AI in E-commerce-AI in E-Tourism-AI in Industry-AI in Medicine.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Represent problems in symbolic logic
CO2 :	Use the knowledge and the process of inference to derive new facts
CO3:	Formulate a problem and find the solution using search techniques and probabilistic methods
CO4:	Build AI system using AI technologies and expert system.
CO5:	Design machine learning model for real world problems
CO6:	Explain the basic concepts of neural network

TEXT BOOKS:

1. Rajendra Akerkar, “Introduction to Artificial Intelligence”, PHI Learning Private Limited, 2012
2. Richard E Neapolitan, “Artificial Intelligence: With an Introduction to Machine Learning”, CRC Press, Second Edition, 2018.

REFERENCE BOOKS:

1. Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson education, Third edition, 2014.
2. Nils.J.Nilsson, "Artificial Intelligence: A new synthesis", Elsevier, July 2003.
3. Andries P.Engelbrecht, "Computational Intelligence: An Introduction", John Wiley & Sons, 2nd edition, 2007.
4. John Fulcher, L.C. Jain, “Computational Intelligence: A Compendium, Studies in Computational Intelligence”, Vol.115, Springer, 2008.

U23EEV42	DATA SCIENCE FOR ENGINEERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To describe the life cycle of Data Science and computational environments for data scientists using Python.
2. To describe the fundamentals for exploring and managing data with Python
3. To examine the various data analytics techniques for labeled/columnar data using Python
4. To demonstrate a flexible range of data visualizations techniques in Python
5. To describe the various Machine learning algorithms for data modeling with Python

UNIT I INTRODUCTION TO DATA SCIENCE 9

Introduction to Data Science and its importance - Data Science and Big data-, The life cycle of Data Science- The Art of Data Science - Work with data – data Cleaning, data Munging, data manipulation. Establishing computational environments for data scientists using Python with IPython and Jupyter.

UNIT II TOWARDS DATA SCIENCE USING NUMPY 9

Understanding Data Types in Python - The Basics of NumPy Arrays - Computation on NumPy Arrays: Universal Functions - Aggregations: Min, Max, and Everything in Between Computation on Arrays: Broadcasting-Comparisons, Masks, and Boolean Logic Fancy Indexing-Sorting Arrays

UNIT III DATA MANIPULATION WITH PANDAS 9

Installing and Using Pandas, Introducing Pandas Objects, Data Indexing and Selection. Operating on Data in Pandas, Handling Missing Data, Hierarchical Indexing Combining Datasets: Concat and Append, Combining Datasets: Merge and Join. Aggregation and Grouping, Pivot Tables, Vectorized String Operations, Working with Time Series.

UNIT IV DATA VISUALIZATION WITH MATPLOTLIB 9

General Matplotlib Tips, Simple Line Plots, Simple Scatter Plots, Visualizing Errors Density and Contour Plots, Histograms, Binnings, and Density, Customizing Plot Legends Customizing Color bars, Multiple Subplots, Text and Annotation, Customizing Ticks Customizing Matplotlib: Configurations and Stylesheets, Geographic Data with Base map.

UNIT V MACHINE LEARNING USING PYTHON 9

Intro Machine Learning: Categories of Machine Learning algorithms, Dimensionality reduction- Introducing Scikit- Application: Exploring Hand-written Digits. Feature Engineering- Naive Bayes Classification - Linear Regression - k-Means Clustering.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Identify phases involved in the life cycle of Data Science
CO2:	Pre-process the data manipulation in Python
CO3:	and manage the data for efficient storage
CO4:	Realize the various data analytics techniques for labeled/columnar Data using Python Pandas
CO5:	Explore a flexible range of data visualizations approaches in Python.
CO6:	Analyze various Machine learning algorithms for data modeling with Python

TEXT BOOKS:

1. Python Data Science Handbook-Essential Tools for Working with Data, Jake Vander Plas, O'Reilly Media, 2016.
2. Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly, 2015.

REFERENCE BOOKS:

1. Python for Data Analysis, Wes Mckinney, O'Reilly Media, 2013.
2. Field Cady, "Data Science Hand Book", John Wiley & Sons, 2017.
3. Fundamentals of Data Science, Samuel Burns, Amazon KDP printing and Publishing, 2019.
4. Doing Data Science, Straight Talk From The Frontline, Cathy O'Neil and Rachel Schutt. O'Reilly. 2014.
5. Tony Ojeda, Sean Patrick Murphy, Benjamin Bengfort, Abhijit Dasgupta, "Practical Data Science Cookbook", Packt Publishing Ltd., 2014
6. Nathan Yau, "Visualize This: The Flowing Data Guide to Design, Visualization, and Statistics", Wiley, 2011.
7. Shai Vaingast, "Beginning Python Visualization Crafting Visual Transformation Scripts", Apress, 2nd edition, 2014.

U23ECT43	DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To learn discrete fourier transform, properties of DFT and its application to linear filtering
2. To understand the characteristics of digital filters, design digital IIR and FIR filters and apply these filters to filter undesirable signals in various frequency bands
3. To understand the effects of finite precision representation on digital filters
4. To understand the effects of finite precision representation on digital filters
5. To understand the fundamental concepts of multi rate signal processing and its applications

UNIT I DISCRETE FOURIER TRANSFORM 9

Sampling Theorem, concept of frequency in discrete-time signals, summary of analysis & synthesis equations for FT & DTFT, frequency domain sampling, Discrete Fourier transform (DFT) - deriving DFT from DTFT, properties of DFT - periodicity, symmetry, circular convolution. Linear filtering using DFT. Filtering long data sequences - overlap save and overlap add method. Fast computation of DFT - Radix-2 Decimation-in-time (DIT) Fast Fourier transform (FFT), Decimation-in-frequency (DIF) Fast Fourier transform (FFT). Linear filtering using FFT.

UNIT II INFINITE IMPULSE RESPONSE FILTERS 9

Characteristics of practical frequency selective filters. characteristics of commonly used analog filters - Butterworth filters, Chebyshev filters. Design of IIR filters from analog filters (LPF, HPF, BPF, BRF) - Approximation of derivatives, Impulse invariance method, Bilinear transformation. Frequency transformation in the analog domain. Structure of IIR filter - direct form I, direct form II, Cascade, parallel realizations.

UNIT III FINITE IMPULSE RESPONSE FILTERS 9

Design of FIR filters - symmetric and Anti-symmetric FIR filters - design of linear phase FIR filters using Fourier series method - FIR filter design using windows (Rectangular, Hamming and Hanning window), Frequency sampling method. FIR filter structures - linear phase structure, direct form realizations.

UNIT IV FINITE WORD LENGTH EFFECTS 9

Fixed point and floating point number representation - ADC - quantization - truncation and rounding - quantization noise - input / output quantization - coefficient quantization error - product quantization error - overflow error - limit cycle oscillations due to product quantization and summation - scaling to prevent overflow.

UNITV DSP APPLICATIONS 9

Multirate signal processing: Decimation, Interpolation, Sampling rate conversion by a rational factor – Adaptive Filters: Introduction, Applications of adaptive filtering to equalization-DSP ArchitectureFixed and Floating point architecture principles.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Apply DFT for the analysis of digital signals and systems
CO2: Design IIR and FIR filters
CO3: Characterize the effects of finite precision representation on digital filters
CO4: Design multirate filters
CO5: Apply adaptive filters appropriately in communication systems
CO6: Design floating point architecture

TEXT BOOKS:

1. John G. Proakis and Dimitris G.Manolakis, Digital Signal Processing – Principles, Algorithms and Applications, Fourth Edition, Pearson Education / Prentice Hall, 2007
2. A. V. Oppenheim, R.W. Schafer and J.R. Buck, ―Discrete-Time Signal Processing", 8th Indian Reprint, Pearson, 2004.

REFERENCE BOOKS:

1. Emmanuel C. Ifeachor& Barrie. W. Jervis, "Digital Signal Processing", Second Edition, Pearson Education / Prentice Hall, 2002.
2. Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach", Tata Mc Graw Hill, 2007.
3. Andreas Antoniou, "Digital Signal Processing", Tata Mc Graw Hill, 2006.

U23EEV44	FUNDAMENTALS OF ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To develop a knowledge in basics of robotics.
2. To understand the basic homogeneous transformation matrices
3. To study the forward and inverse kinematics.
4. To know the various sensors and actuators
5. To know the velocity and force feedback

UNIT I ROBOT FUNDAMENTALS 9

Classification of Robots - History of Robotics - Robot Components - Robot Joints and Degrees of Freedom – Coordinates and Reference Frames - Robot Workspace – Applications - Social Issues.

UNIT II RIGID MOTIONS AND HOMOGENEOUS TRANSFORMATIONS 9

Representation of Positions and rotations in matrix form - Rotational Transformations - Rotation with respect to the current coordinate frame - Rotation with respect to a fixed frame - Parameterizations of Rotations - Euler Angles - Roll, Pitch, Yaw Angles - Axis/Angle Representation - Homogeneous Transformations.

UNIT III FORWARD AND INVERSE KINEMATICS 9

Forward Kinematics - Kinematic Chains - Denavit Hartenberg Representation - Existence and uniqueness issues - Assigning the coordinate frames -Inverse Kinematics - Kinematic Decoupling - Inverse Position - Inverse Orientation - Degeneracy and Dexterity.

UNIT IV ROBOTIC SENSORS AND ACTUATORS 9

Sensor Characteristics – Position, Velocity, Acceleration Sensors - Force and Pressure Sensors - Torque Sensors - Visible Light and Infrared Sensors - Touch and Tactile Sensors - Proximity Sensors - Range Finders – other sensors Characteristics of Actuating Systems - Comparison of Actuating Systems - Hydraulic Actuators - Pneumatic Devices - Electric Motors and their types - Control of Electric Motors (PWM control and direction control with H bridge) – Magnetostrictive Actuators - Shape-Memory Type Metals – MEMS based actuators - Other Systems.

UNITV MOTIONS AND VELOCITIES 9

Differential Motions and Velocities - Differential Relationships – Jacobian - Differential Motions of a Frame -Calculation of the Jacobian - Inverse Jacobian – Force feedback (elementary) – end effector systems – case study with egg picker.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Understand the fundamentals of robotics.
CO2: Explain about rigid body transformations.
CO3: Describe the forward and inverse kinematics.
CO4: Explain about various actuators.
CO5: Explain about various robotic sensors
CO6: Illustrate end effector motion with an example

TEXT BOOKS:

1. Saeed Benjamin Niku," Introduction To Robotics: Analysis, Control, Applications", John Wiley & sons, 2011
2. Mark W. Spong," Robot Dynamics and Control", Wiley,2005

REFERENCE BOOKS:

1. Paul Sandin ,"Robot mechanisms and mechanical devices illustrated", McGraw-Hill, 2003
2. Jorge Angeles, "Fundamentals of Robotic Mechanical Systems: Theory, Methods, and Algorithms", Springer International, 2014

U23BMT41	BIOMEDICAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To know the Physiological systems of the human body and relate them to the parameters that have clinical importance.
2. To understand the Medical equipments that are actually in use at the present day in the healthcare centre
3. To develop Patient life assisting devices used in Hospitals.
4. To develop Therapeutic and Medical imaging equipments
5. To understand the Telemedicine and Electrical safety in clinical environment.

UNIT I HUMAN PHYSIOLOGICAL SYSTEM 9

Cell and its Structure – Action potential – Resting potential – Propagation of Action potential and Sodium pump – Nerve cell: Neuron – Axon – Synapse – Central Nervous System-Peripheral Nervous System – Respiratory System-Electro Physiology of Cardiopulmonary Circulation system.

UNIT II NON-ELECTRICAL PARAMETER MEASUREMENTS 9

Measurement of Blood pressure – Cardiac Output measurement – Measurement of Heart Sounds – Phonocardiography – Measurement of Partial pressure of Carbon dioxide (PaCO2) and Partial pressures of Oxygen (PaO2) in the Arterial blood – Measurement of lung volumes: Spirometry.

UNIT III ELECTRO–PHYSIOLOGICAL PARAMETERS MEASUREMENTS 9

Basic components of a Biomedical system – Bio-Electrodes : Micro, Needle and Surface Electrodes – Different Lead configurations and recording methods of Electrocardiograph(ECG) – Electroencephalograph(EEG) – Brain Waves: Alpha, Beta, Theta and Delta waves and their frequency spectrum – Electromyography (EMG)- Electroretinography (ERG).

UNIT IV PATIENT LIFE ASSISTING AND THERAPEUTIC EQUIPMENTS 9

Pacemakers and its types –Defibrillators: D.C and AED – Ventilators: Pressure limited, Volume limited and Servo controlled ventilators – Nerve and Muscle stimulators-Surgical diathermy machines: Short wave, Microwave and Ultrasonic diathermy – Hemo and Peritoneal dialyzers.

UNITV MEDICAL IMAGING EQUIPMENTS & ELECTRICAL SAFETY IN CLINICAL ENVIRONMENT 9

Block diagram, operations and applications of X-Ray machines– Computer Tomography (CT) – Magnetic Resonance Imaging (MRI) System – Ultrasonography – Medical Thermography – Telemedicine – Electrical safety in Clinical environment.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Understand the physiology of the heart, lung, blood circulations and respirations.

CO2: Know the usage of latest medical equipments available for measurement of non-electrical parameters in the physiological systems of the human body.

CO3: Obtain the in-depth knowledge in various electrical origins of recording methods of ECG, EEG, EMG and ERG.

CO4: Know the latest procedure adopted for providing Medical assistance through telemetry

CO5: Know the latest procedure adopted for Therapeutic equipments used for diagnostic and surgery purposes.

CO6: Aware of modern methods of imaging techniques used for diagnostic purpose in the health care centre.

TEXT BOOKS:

1. Khandpur R.S., "Handbook of Bio-Medical Instrumentation", TataMcGraw Hill Publishing Co Ltd., 2013.
2. Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, "Bio-Medical Instrumentation and Measurements", Pearson Education, 2011 / PHI, 2nd Edition.

REFERENCE BOOKS:

1. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, India, 3rd Edition, 2013.
2. Geddes L.A. and Baker L.E., "Principles of Applied Bio-Medical Instrumentation", John Wiley & Sons, 3rd Edition, 2013.
3. Ed. Joseph D. Bronzino, "The Biomedical Engineering Handbook", Second Edition, Boca Raton, CRC Press LLC, 2000.
4. Barbara L. Christe, "Introduction to biomedical Instrumentation, "Cambridge University Press, 2009.
5. Joseph J. Carr and John M.Brown," Introduction to Biomedical Equipment Technology,'' Pearson,4th edition,2002.

U23EEV46	ADVANCED MICROPROCESSOR AND MICROCONTROLLERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Architecture of 8086,80186,80286,80386,and 80486
2. Architecture ofPentium processors
3. Architecture and instruction set of PIC 18 series microcontroller
4. Internal peripheral units of PIC 18 microcontrollers and using them for interfacing applications
5. Designing systems for motor control

UNIT I 8086 ARCHITECURE 9

Architecture – memory accessing - Pin details – Addressing Modes – Instruction Format – Interrupt Structure .

UNIT II ADVANCED MICROPROCESSORS 9

Architecture 80186 – Architecture 80286 – 80386 -80486 – Pentium Processor

UNIT III PIC18F MICROCONTROLLER 9

Architecture – Memory Organization-Addressing Modes – Instruction Set – PIC Programming

UNIT IV PERIPHERALS OF PIC MICROCONTROLLER 9

I/O ports -Timer – CCP module –Interrupts- UART – ADC and Programming

UNIT V SYSTEM DESIGN – CASE STUDY 9

Interfacing of LCD - Motor Control – Generation of waveforms (Sine, Triangular, Square, Ramp)

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Understand the architecture and interrupt structure of 8086 microprocessor
CO2 :	Understand the architecture of 80186, 80286, 80386, 80486 and Pentium microprocessor
CO3:	Develop programs based on the architecture and instruction set of PIC 18 series microcontroller
CO4:	Design interfacing applications based on internal peripheral units of PIC 18 microcontrollers and programming them
CO5:	Understand interfacing of microprocessor for various applications
CO6:	Understand the instruction set of 80186, 80286, 80386, 80486 and Pentium microprocessor

TEXT BOOKS:

1. Senthil Kumar N.,Saravanan M.,Jeevananthan.S., Shah S.K, "Microprocessors and Interfacing" Oxford University Press, New Delhi, 2015.
2. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey, "PIC Microcontroller and Embedded Systems using Assembly and C for PIC18", Pearson Education, 2008.

REFERENCE BOOKS:

1. Douglas V Hall, "Microprocessors And Interfacing", 3rdEdition, McGraw Hill Education, 2012
2. Rafiquzzaman. M, "Microprocessors Theory and applications-Intel and Motorola", Prentice Hall India, 2001.

3. Walter A Tribal &Avtar Singh, “The 8088 & 8086 Microprocessors”, Pearson, Fourth Edition, 2007
4. Mandal S.K.,“Microprocssors and Microcontrollers”, McGraw Hill education,2011
5. Rafiquzzaman.M,“Microcontroller Theory and Applications with the PIC18F”Wiley,2nd Edition,2018

VERTICAL V CONVERTERS AND DRIVES

		L	T	P	C
U23EEV51	**MULTILEVEL POWER CONVERTERS**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To learn multilevel topology (Symmetry & Asymmetry) with common DC bus link.
2. To study the working of cascaded H Bridge, Diode Clamped and Flying Capacitor MLI.
3. To study the working of MLI with reduced switch count.
4. To simulate three level diode clamped MLI and three level flying capacitor based MLI with resistive and reactive load
5. To simulate the MLI with reduced switch count.

UNIT I MULTILEVEL TOPOLOGIES 9

Introduction – Generalized Topology with a Common DC bus – Converters derived from the generalized topology – symmetric topology without a common DC link – Asymmetric topology.

UNIT II CASCADED H-BRIDGE MULTILEVEL INVERTERS 9

Introduction -H-Bridge Inverter, Bipolar Pulse Width Modulation, Unipolar Pulse Width Modulation. Multilevel Inverter Topologies, CHB Inverter with Equal DC Voltage, H-Bridges with Unequal DC Voltages – PWM, Carrier-Based PWM Schemes, Phase-Shifted Multicarrier Modulation, Level-Shifted Multicarrier Modulation, Comparison Between Phase- and Level-Shifted PWM Schemes-Staircase Modulation.

UNIT III DIODE CLAMPED MULTILEVEL CONVERTER 9

Introduction – Converter structure and Functional Description – Modulation of Multilevel converters– Voltage balance Control – Effectiveness Boundary of voltage balancing in DCMC converters –Performance results.

UNIT IV FLYING CAPACITOR MULTILEVEL CONVERTER 9

Introduction – Flying Capacitor topology – Modulation scheme for the FCMC – Dynamic voltage balance of FCMC.

UNITV MULTILEVEL CONVERTER WITH REDUCED SWITCH COUNT 9

Multilevel inverter with reduced switch count-structures, working principles and pulse generation methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Examine the different topologies of multilevel inverters (MLIs) with and without DC link capacitor.
CO2:	Examine the performance of MLIs with Bipolar Pulse Width Modulation (PWM) Unipolar PWM Carrier-Based PWM Schemes Phase Level Shifted Multicarrier Modulation.
CO3:	Demonstrate the working principles of Cascaded H-Bridge MLI, diode clamped MLI, flying capacitor MLI and MLI with reduced switch count
CO4:	Analyze the voltage balancing performance in Diode clamped MLI.
CO5:	Simulate three level, capacitor clamed and diode clamped MLI with R and RL load.
CO6:	Design and implement multi-level converters to real time application

TEXT BOOKS:

1. Rashid M.H,"Power Electronics Circuits, Devices and Applications", Prentice Hall India, Third Edition, New Delhi, 2014 Pearson 4th edition.
2. Sergio Alberto Gonzalez, Santiago Andres Verne, Maria Ines Valla,"Multilevel Converters for Industrial Applications", CRC Press, 22-Jul-2013, 2017 1st Edition.
3. BinWu, Mehdi Narimani,High Power Converters and AC drives by IEEE press 2017, 2nd Edition.

REFERENCE BOOKS:

1. Thomas A. Lipo, Pulse Width Modulation for Power Converters: Principles and Practice, D.Grahame Holmes, John Wiley & Sons, Oct-2003, 1st Edition.
2. Fang Lin Luo, Hong Ye,Advanced DC/AC Inverters: Applications in Renewable Energy, CRC Press, 22-Jan-2013, 2017, 1st Edition.
3. Hani Vahedi, Mohamed Trabelsi, Single-DC-Source Multilevel Inverters, Springer, 2019, 1st Edition.
4. Ersan Kabalcı, Multilevel Inverters Introduction and Emergent Topologies, Academic Press Inc,2021, 1st Edition.
5. Iftekhar Maswood, Dehghani Tafti,Advanced Multilevel Converters and Applications in Grid Integration, Wiley, 2018, 1st Edition.

		L	T	P	C
U23EEV52	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To learn the various types of renewable sources of energy.
2. To understand the electrical machines to be used for wind energy conversion systems.
3. To learn the principles of power converters used in solar PV system.
4. To study the principle of power converters used in Wind system.
5. To simulate the AC-DC, AC-AC Converters, Matrix Converters and PWM Inverters.

UNIT I INTRODUCTION TO RENEWABLE ENERGY SYSTEMS 9

Classification of Energy Sources – Importance of Non-conventional energy sources – Advantagesand disadvantages of conventional energy sources - Environmental aspects of energy - Impacts of renewable energy generation on the environment - Qualitative study of renewable energyresources: Ocean energy, Biomass energy, Hydrogen energy, - Solar Photovoltaic (PV), Fuel cells:Operating principles and characteristics, Wind Energy: Nature of wind, Types, control strategy,operating area.

UNIT II ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS (WECS) 9

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: Line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing. Simulation of line commutated converters, buck/boost converters. Analysis: Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems, Grid integrated solar PV Systems - Grid Connection Issues.

UNIT IV POWER CONVERTERS FOR WIND SYSTEMS 9

Power Converters: Three-phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid-Interactive Inverters - Matrix converter.

UNITV HYBRID RENEWABLE ENERGY SYSTEMS 9

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Diesel-PV, Wind-PV, Micro hydel-PV, Biomass-Diesel systems - Maximum Power Point Tracking (MPPT).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Examine the available renewable energy sources.
CO2:	Demonstrate the working principles of electrical machines and power converters used for wind energy conversion system.
CO3:	Demonstrate the principles of power converters used for solar PV systems.
CO4:	Examine the available hybrid renewable energy systems.
CO5:	Simulate AC-DC converters, buck/boost converters, AC-AC converters and PWM inverters.
CO6:	Design and implement power converters to real time application

TEXT BOOKS:

1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 2009, 7th impression.
2. Rashid .M. H "Power electronics Hand book", Academic press,2nd Edition, 2006 4th Edition,2017

REFERENCE BOOKS:

1. Rai. G.D, "Non-conventional energy sources", Khanna publishers, 6th Edition, 2017. 137
2. Rai. G.D," Solar energy utilization", Khanna publishers, 5th Edition, 2008.
3. Gray, L. Johnson, "Wind energy system", prentice hall of india, 2nd Edition, 2006.
4. H.Khan "Non-conventional Energy sources ",Tata McGraw-hill Publishing Company, New Delhi, 2017, 3rd Edition.

U23EEV53	CONTROL OF POWER ELECTRONICS CIRCUITS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To learn the basics of control system simulation.
2. To do symbolic calculation
3. To study the principles of sliding mode control and the way of apply smc for buck Converter.
4. To learn the concept of power factor correction.
5. To design simulate smc for buck converter and power factor correction circuit with controller

UNIT I SIMULATION BASICS IN CONTROL SYSTEMS 9

Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots,bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions,RHP Pole and RHP Zero Functions), state space modelling-transfer function from state space Model.

UNIT II SYMBOLIC CALCULATIONS 9

Symbolic Variables - Symbolic Vector Variables, Commands for Handling Polynomial Expressions- Extracting Parts of a Polynomial -. Factorization and Roots of Polynomials, Symbolic Matrix Algebra - Operations with Symbolic Matrices - Other Symbolic Matrix Operations.

UNIT III SLIDING MODE CONTROL BASICS 9

Introduction- Introduction to Sliding-Mode Control- Basics of Sliding-Mode Theory-Application of Sliding-Mode Control to DC-DC Converters—Principle-Sliding mode control of buck converter.

UNIT IV POWER FACTOR CORRECTION CIRCUITS 9

Introduction, Operating Principle of Single-Phase PFCs, Control of boost converter based PFCs, Designing the Inner Average-Current-Control Loop, Designing the Outer Voltage-Control Loop, Example of Single-Phase PFC Systems.

UNITV CONTROLLER DESIGN FOR PFC CIRCUITS 9

Power factor correction circuit using other SMPS topologies: C'uk and SEPIC converter - PFC circuits employing bridgeless topologies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	To calculate transfer function for constant, differential, integral, First order and Second order factors.
CO2:	To illustrate the effect of poles and zero's in the 's' plane.
CO3:	To select Symbolic equations for solving problems related with Matrices, Polynomial and vectors.
CO4:	To compute the control expression for DC – DC buck converter using sliding mode control theory.
CO5:	To determine the controller expression for power factor correction circuits.
CO6:	Design and implement power controllers

TEXT BOOKS:

1. Feedback Control problems using MATLAB and the Control system tool box By Dean Frederick and Joe Chow, 2000, 1st Edition, Cengage Learning.
2. Ned Mohan,"Power Electronics: A First Course", Johnwiley, 2013, 1st Edition.
3. Marian K. Kazimierczuk and AgasthyaAyachit,"Laboratory Manual for Pulse-Width Modulated DC-DC Power Converters", Wiley 2016, 1st Edition.
4. Power Electronics handbook, Industrial Electronics series, S.K.Varenina, CRC press, 2002,1st Edition.

REFERENCE BOOKS:

1. Sliding mode control for Switching Power Converters:, Techniques and Implementation, Slew-Chong Tan, Yuk Ming Lai Chi-Kong Tse, 1st Edition, CRC Press.
2. Andre Kislovski, "Dynamic Analysis of Switching-Mode DC/DC Converters", Springer 1991.
3. MATLAB Symbolic Algebra and Calculus Tools, Lopez Cesar, Apress, 2014.

U23EEV54	SMPS AND UPS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To learn the working of isolated & non-isolated DC-DC converters
2. To design isolated & non-isolated DC-DC converters.
3. To drive the equations related with converter dynamics.
4. To design and simulate P, PI & PID controller for buck, boost and buck-boostConverters.
5. To identify and study different configurations of the UPS.

UNIT I ANALYSIS OF NON-ISOLATED DC-DC CONVERTERS 9

Basic topologies: Buck, Boost and Buck-Boost - 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.

UNIT II ANALYSIS OF ISOLATED DC-DC CONVERTERS 9

Introduction - classification- forward- flyback- pushpull – half bridge – full bridge topologies- C'uk converter as cascade combination of boost followed by buck – isolated version of C'uk converter - design of SMPS – Introduction to design of magnetic components for SMPS, using relevant software- Simulation of bidirectional DC DC converter (both non-isolated and isolated) considering EV as an example application.

UNIT III CONVERTER DYNAMICS 9

AC equivalent circuit analysis – State space averaging – Circuit averaging – Transfer function model for buck, boost and buck-boost converters – Simulation of basic topologies using state space model derived – Comparison with the circuit model based simulation already carried out.

UNIT IV CONTROLLER DESIGN 9

Review of P, PI, and PID control concepts – gain margin and phase margin – Bode plot based analysis – Design of controller for buck, boost and buck-boost converters.

UNITV POWER CONDITIONERS AND UPS 9

Introduction – Power line disturbances – Power conditioners – UPS: Offline and On-line – Need for filters – Filter for PWM VSI – Front-end battery charger – boost charger.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Demonstrate the working of buck boost and buck- boost converters in continuous and discontinuous conduction mode.
CO2:	Build buck/boost converters using suitable design method.
CO3:	Analyze the behaviors of isolated DC-DC converters and to design SMPS for battery operated vehicle.
CO4:	Compute state space averaged model and transfer function for buck, boost and buckboost converters.
CO5:	Demonstrate the P, PI and PID controller performance analytically and by simulation for buck boost and buck- boost converters.
CO6:	Design and implement suitable SMPS and UPS for real time application

TEXT BOOKS:

1. Robert W. Erickson & Dragon Maksimovic, ” Fundamentals of Power Electronics”, Third Edition, 2020
2. Ned Mohan,” Power Electronics: A First Course”, Johnwiley, 2013.

REFERENCE BOOKS:

1. Marian K. Kazimierczuk and Agasthya Ayachit,”Laboratory Manual for Pulse-Width Modulated DC– DC Power Converters”, Wiley 2016.
2. Power Electronics handbook, Industrial Electronics series, S.K.Varenina, CRC press, 2002.
3. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition 2017.

U23EEV55	ELECTRICAL DRIVES AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To understand steady state operation and transient dynamics of a motor load system.
2. To study and analyze the operation of the converter / chopper fed dc drive, both qualitatively and quantitatively.
3. To study and understand the operation and performance of AC Induction motor drives.
4. To study and understand the operation and performance of AC Synchronous motor Drives.
5. To analyze and design the current and speed controllers for a closed loop solid state DC motor drives

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 motor.

UNIT II CONVERTER / CHOPPER FED DC MOTOR DRIVE 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 – 4 quadrant operation of converter / chopper fed drive

UNIT III INDUCTION MOTOR DRIVES 9

Stator voltage control – energy efficient drive – v/f control – constant air gap flux – field weakening mode – voltage / current fed inverter – closed loop control,

UNIT IV SYNCHRONOUS MOTOR DRIVES 9

V/f control and self-control of synchronous motor: Margin angle control and power factor control – permanent magnet synchronous motor.

UNITV DESIGN OF CONTROLLERS FOR DRIVES 9

Transfer function for DC motor / load and converter – closed loop control with current and speed feedback – armature voltage control and field weakening mode – design of controllers; current controller and speed controller-converter selection and characteristics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Understand the basic requirements of motor selection for different load profiles.
CO2: Analyse the steady state behavior and stability aspects of drive systems.
CO3: Analyse the dynamic performance of the DC drive using converter and chopper control.
CO4: Simulate the induction motor drive.
CO5: Design the synchronous motor drive. .
CO6: Design and implement controller for electrical drives.

TEXT BOOKS:

1. Gopal K.Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 2nd Edition January 2010.
2. Bimal K.Bose. Modern Power Electronics and AC Drives, Pearson Education, 2002 1st Edition.

REFERENCE BOOKS:

1. S.K.Pillai, A First course on Electrical Drives, Wiley Eastern Limited, 3rd Edition 2012.
2. Murphy J.M.D and Turnbull, Thyristor Control of AC Motor, Pergamon Press, Oxford 1988, 1st Edition.
3. Gopal K.Dubey, Power semiconductor controlled Drives, Prentice Hall Inc., New Jersey,1989, 1st Edition
   R.Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Prentice hall of India, 2001, 1st Edition.

U23EEV56 ANALYSIS OF ELECTRICAL MACHINES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To model & simulate all types of DC machines
2. To develop reference frame equations for various elements like R, L and C
3. To model an induction (three phase and 'n' phase) and synchronous machine
4. To drive reference frame equations for induction and synchronous machine
5. To study the need and working of multiphase induction and synchronous machine

UNIT I MODELING OF BRUSHED-DC ELECTRIC MACHINERY 9

Fundamentals of Operation – Introduction – Governing equations and modeling of Brushed DC-Motor –Shunt, Series and Compound – State model derivation – Construction of Model of a DC Machine using state equations- Shunt, Series and Compound..

UNIT II REFERENCE FRAME THEORY 9

Historical background – phase transformation and commutator transformation – transformation of variables from stationary to arbitrary reference frame .

UNIT III INDUCTION MACHINES 9

Three phase induction machine - equivalent circuit– free acceleration characteristics – voltage and torque equations in machine variables and arbitrary reference frame variables – Simulation under no load and load conditions- Machine variable form, arbitrary reference variable form.

UNIT IV SYNCHRONOUS MACHINES 9

Three phase synchronous machine - voltage and torque equations in machine variables and rotor reference frame variables (Park's equations).

UNITV MULTIPHASE (MORE THAN THREE-PHASE) MACHINES CONCEPTS 9

Preliminary Remarks - Necessity of Multiphase Machines - Evolution of Multiphase Machines- Advantages of Multiphase Machines - Working Principle - Multiphase Induction Machine, Multiphase Synchronous Machine -Modeling of 'n' phase machine. Applications of Multiphase Machines.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Find the modeling for a brushed DC-Motor (Shunt, Series, Compound and separately excised motor) and to simulate DC motors using state models
CO2:	Apply reference frame theory for, resistive and reactive elements (three phase)
CO3:	Compute the equivalent circuit and torque of three phase induction motor and synchronous motor in machine variable arbitrary reference frame variable
CO4:	Find the need and advantages of multiphase machines
CO5:	Demonstrate the working of multiphase induction and synchronous machine.
CO6:	Implement and analyse the electrical machines.

TEXT BOOKS:

1. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek, "Analysis of Electric Machinery and Drive Systems", 3rd Edition, Wiley-IEEE Press, 2013.
2. R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson Education, 1st Imprint, 2015, 1st Edition.

REFERENCE BOOKS:

1. Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7th Edition, 2020.
2. Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011, 1st Edition.
3. R.Ramanujam, Modeling and Analysis of Electrical Machines, I.k.International Publishing House Pvt.Ltd,2018.
4. Chee Mun Ong, Dynamic Simulation of Electric Machinery using MATLAB, Prentice Hall, 1997,1st Edition.

Atif Iqbal,Shaikh Moinoddin, Bhimireddy Prathap Reddy, Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Wiley,2021,1st Edition

VERTICAL VI INTERNET OF THINGS

		L	T	P	C
U23EEV61	**SENSORS AND ACTUATORS**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To recognize different types of sensors and actuators for different environments.
2. To learn about the different measurements using sensors
3. To identify suitable sensors and actuators for developing engineering applications.
4. To analyse electric and magnetic sensors for real time application
5. To implement various sensors and actuators to application

UNIT I CLASSIFICATION AND PERFORMANCE CHARACTERISTICS OF SENSORS AND ACTUATORS **9**

Classification of Sensors and Actuators - General Requirements for Interfacing - Units and Measures - Transfer function - Impedance and Impedance matching - Range, Span, Resolution, Accuracy, Errors, Repeatability, Sensitivity and Sensitivity analysis - Hysteresis , Nonlinearity and saturation - Frequency Response, Response Time and Bandwidth - Calibration - Excitation - Deadband - Reliability.

UNIT II TEMPERATURE SENSORS AND THERMAL ACTUATORS **9**

Units of Temperature - Thermo resistive Sensors: Thermistors, Resistance temperature sensors - Silicon resistive sensors - Thermoelectric Sensors - PN Junction Temperature Sensors - Optical and Acoustical Sensors - Thermo mechanical sensors and Actuators.

UNIT III OPTICAL SENSORS AND ACTUATORS **9**

Optical Units and materials - Effects of Optical Radiation - Quantum-Based Optical Sensors - Photoelectric Sensors - Coupled Charge (CCD) Sensors and Detectors - Thermal-Based Optical Sensors - Active Far Infrared (AFIR) Sensors - Optical Actuators.

UNIT IV ELECTRIC, MAGNETIC SENSORS AND ACTUATORS **9**

Units - The Electric Field: Capacitive Sensors and Actuators - Magnetic Fields: Inductive sensors and Hall effect sensors - Magnetohydrodynamic (MHD) Sensors and Actuators - Magnetometers - Magnetic Actuators - Voltage and Current Sensors.

UNITV MECHANICAL SENSORS AND ACTUATORS, RADIATION SENSORS, MEMS AND SMART SENSORS **9**

Force Sensors – Accelerometers - Pressure Sensors – Gyroscopes - Radiation Sensors - Microwave Radiation - Antennas as Sensors and Actuators - MEMS Sensors and Actuators - Smart Sensors and Actuators - Sensor Networks.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end ofthe course thestudentswouldbeableto

CO1 : Analyze the Performance characteristics of Sensors, and Actuators
CO2 : Illustrate the concepts of Thermal sensors and actuators
CO3: Explain the concept of Optical sensors and actuators
CO4: Narrate the concept of Electric and magnetic sensors and actuators
CO5: Apply suitable sensors and actuators for engineering applications.
CO6: Design the sensors and actuators to real time application

TEXT BOOKS:

1. Nathan Ida, “Sensors, Actuators and their Interfaces”, Scitech publishing, 2013.
2. Patranabis D, “Sensor and Actuators”, Prentice Hall of India (Pvt) Ltd. 2005

REFERENCE BOOKS:

1. Clarence W. de Silva, “Sensors and Actuators: Engineering System Instrumentation”, 2nd Edition, CRC Press, 2015
2. Ernest O. Doeblin, “Measurement system, Application and design”, Tata McGraw Hill Publishing Company Ltd., Fifth Edition, 2004
3. Bradley D.A., Dawson D, Burd N C ,Loader A J,” Mechatronics”, Thomson Press India Ltd., 2004
4. Renganathan.S,”Transducer Engineering”, Allied Publishers (P) Ltd., 2003.
5. Bolton W.,” Mechatronics”, 4th edition, Pearson,2011.

U23EEV62	IOT ARCHITECTURE AND FRAMEWORK	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To understand the concepts and perspectives of Internet of Things
2. To apply the knowledge on IoT architecture and modules
3. To design Internet of Things with Embedded systems using data analytics
4. To recognize IOT frame work and industrial IOT to real time
5. To implement IOT data management to real time application

UNIT I IOT CONCEPTS AND ENABLING TECHNOLOGIES 9

Introduction – Definition and Characteristics of IoT – Benefits of IoT –Physical design of IoT – Logical design of IoT – IoT Enabling Technologies–Resource Management – Resource Partitioning – Computation Offloading - Identification and Resource/Service Discovery – IoT Levels.

UNIT II IOT ARCHITECTURE AND ITS CORE MODULES 9

Reference architecture for IoT – SOA based & API oriented architecture – Four layer architecture – Seven Layer architecture – fog computing – Open stack cloud architecture – Gateways, Edge Devices, Data acquisition systems, Cloud services.

UNIT III EMBEDDED PROTOTYPING OF IOT 9

Overview of Raspberry Pi – General-Purpose Input/Outputs – Sensors with Raspberry Pi – Actuators with Raspberry Pi –Web Server with Raspberry Pi – Raspberry Pi as a Database Server – ESP8266 WiFi Module – Block Diagram, Features, applications.

UNIT IV IOT FRAMEWORK & INDUSTRIAL IOT 9

IoT Value Chain – IoT Platforms – Cisco, Salesforce, Azure IoT, Eclipse IoT, Thingworx, GE Predix, AWS IoT, Watson IoT, Kaa – Introduction to Industrial Internet of Things & Industry 4.0 – IIoT Architecture – Applications and Challenges.

UNITV DATA ANALYTICS & IOT CASE STUDIES 9

IoT Data Management – Analytics –Apache Hadoop–Programming Model, Job Execution, Hadoop Cluster – Case Studies – Smart Parking, Smart Irrigation Control, Air Pollution Monitoring, Forest Fire Detection, Weather Forecasting.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end ofthe course thestudentswouldbeableto

CO1: Determine the supporting technologies for design of IoT applications
CO2: Apply the architecture and core modules for IoT applications
CO3: Develop IoT applications using embedded systems
CO4: Illustrate the necessary framework required for IoT application
CO5: Apply data analytics for IoT applications
CO6: Implement IoT data management to application

TEXT BOOKS:

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things, A Hands-on-Approach”, 1st Edition, Universities press Pvt. Ltd., India, 2015.
2. Mayur Ramgir, “Internet of Things- Architecture, Implementation, and Security”, 1st Edition, Pearson Education, India, 2019

REFERENCE BOOKS:

1. Rajkumar Buyya, Amir Vahid Dastjerdi, “Internet of Things: Principles and Paradigms”, 1st Edition, Elsevier, USA, 2016
2. Dimitrios Serpanos, Marilyn Wolf, “Internet-of-things (IoT) systems: architectures, algorithms, methodologies”, 1st Edition, Springer, UK, 2017.
3. Charles Bell, “Beginning Sensor Networks with Arduino and Raspberry Pi” , 1st Edition, Apress Publishers, USA, 2013.

U23EEV63	COMMUNICATION PROTOCOLS FOR IOT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To discuss the fundamental concepts of internet protocols an standards
2. To examine the protocol standards in data link and networking layer
3. To simulate the different protocols through IoT open source tools.
4. To describe the security issues of protocols in IoT
5. To implement security and privacy techniques

UNIT I EVOLVING IOT STANDARDS 9

Overview and Approaches – IoT Ecosystem – Protocols for IoT- Structural Aspects- Key Technologies-Sensor Technology-RFID technology – Satellite Technology – CoAP – REST – ETSI M2M

UNIT II DATA LINK PROTOCOLS 9

IEEE 802.15.4e - IEEE 802.11 ah – Wireless HART - Z-Wave - Bluetooth Low Energy - Zigbee Smart Energy - DASH7 – Home Plug - G.9959 - LTE-A – LoRa WAN – Weightless - DECT/ULE

UNIT III NETWORK LAYER PROTOCOLS 9

Routing Protocols – RPL – CORPL – CARP - Encapsulation Protocols - 6LoWPAN - 6TiSCH - 6Lo - IPv6 over G.9959 - IPv6 over Bluetooth Low Energy - Session Layer Protocols – MQTT – SMQTT – XMPP – DDS

UNIT IV IOT EDGE COMPUTING 9

Edge Computing – Purpose and Definition– Edge Hardware Architectures – Operating System – Edge Platforms – Virtualisation – Containers – Use Cases – Ambient Computing – Synthetic Sensing.

UNITV SECURITY AND PRIVACY 9

Security Issues in the IoT - Security Mechanisms- Key Agreement, Distribution, and Security Bootstrapping -Key Agreement Protocols. Privacy Issues in the IoT - Role of Authorization - IoT-OAS: Delegation-based Authorization for the Internet of Things - IoT-OAS Application Scenarios

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end ofthe course thestudentswouldbeableto

CO1: Describe the evolving IoT Standards
CO2: Demonstrate and visualize the data link protocols for IoT.
CO3: Elucidate the network protocols and standards for IoT
CO4: Analyse the importance of IoT Edge devices.
CO5: Apply security mechanisms for protocol security.
CO6: Implement communication protocols to real time application.

TEXT BOOKS:

1. Geng, Hwaiyu. "Internet of Things and Data Analytics in the Cloud with Innovation and Sustainability." The Internet of Things & Data Analytics Handbook ,2017.
2. Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri - Internet of Things_ Architectures, Protocols and Standards-Wiley ,2018.
3. Perry Lea, " IoT and Edge Computing for Architects_ Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security, 2nd Edition", Packt Publishing, 2020.

REFERENCE BOOKS:

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014 .
2. Vijay Madisetti, Arshdeep Bahga, "Internet of Things (A Hands-on Approach)", 1st Edition, VPT, 2014.
3. Perry Lea , "Internet of Things for Architects_ Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security",Packt Publishing ,2018
4. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Wiley Publications, 2013.

U23EEV64	CLOUD SERVICES FOR IOT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To comprehend the cloud architecture and its services
2. To illustrate the various sensors and their cloud interfaces
3. To learn the cloud platforms of IoT
4. To understand the various cloud services for IoT
5. To familiarize the applications security issues

UNIT I CLOUD PLATFORM ARCHITECTURE AND SERVICES 9

Cloud computing and service models: Public, Private and Hybrid clouds-Infrastructure as a service(IaaS) - Platfrom as a service(PaaS)-Software as a service(SaaS)-Architectural design of compute and storage clouds: Layered cloud architectural development-Architectural design challenges-Public cloud platforms: GAE,AWS and Azure

UNIT II PROGRAMMING IOT DEVICES FOR CLOUD INTERFACE 9

Basics of Sensors and actuators – examples and working principles of sensors and actuators – Cloud computing and IOT – Arduino/Equivalent Microcontroller platform. IoT Communication Technologies – RFID – Bluetooth – Zigbee – Wifi –Wired Communication

UNIT III CLOUD PLATFORMS FOR IOT 9

Thinkspeak IoT Cloud Platform, Kaa Open Source IoT Cloud Platform, AWS IoT Cloud Platform – AWS IoT Device SDK. Arduino AWS IoT development. Raspberry Pi 3-AWS IoT development

UNIT IV CLOUD SERVICES FOR IOT 9

Service Management in Cloud Computing - Service Level Agreements (SLAs), Managing IoT Data – Looking at Data, Scalability & Cloud Services, Database & Data Stores in Cloud, Large Scale Data Processing.

UNITV SECURITY AND APPLICATIONS 9

Application Safety and Service Vulnerability in Cloud Network- IoT Security and Privacy Preservation-Security and Challenges in Mobile Cloud Computing-The vital role of Fog computing in Internet of Things

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end ofthe course thestudentswouldbeableto

CO1: Build an appropriate cloud architecture and identify the cloud services
CO2: Handle various sensors and the technologies
CO3: Develop IoT applications using cloud platforms
CO4: Integrate the IoT applications into the cloud services
CO5: Access the security issues in applications and networks
CO6: Implement cloud services to real time application

TEXT BOOKS:

1. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From parallel processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. Raj Kamal, "Internet of Things: Architecture and Design Principles", McGraw-Hill Education Pvt. Ltd., 2018.
3. Charalampos Doukas, "Building Internet of Things with the Arduino", Create Space, April 2002.
4. Agus Kurniawan "Learning AWS IoT"Packt Publishing (January 29, 2018)

REFERENCE BOOKS:

1. Dac-Nhuong Le , Chintan Bhatt , Mani Madhukar "Security Designs for the Cloud, IoT, and Social Networking" John Wiley & Sons (11 October 2019)
2. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press, 2013.
3. Marco Schwatrz, "Internet of Things with Arduino Cookbook", Packt Publications, 2016.
4. Rajkumar Buyya, Christian Vecchiola. S.ThamaraiSelvi, "Mastering Cloud Computing", McGraw Hill Education, 2013.
5. Nick Antonopoulos and Lee Gillam, "Cloud Computing: Principles, Systems and Applications", Second Edition, Springer, 2017.

U23EEV65	BIG DATA ANALYTICS FOR IOT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To learn Big data analytics for IoT
2. To get exposure on IoT semantics and big data streaming analytics
3. To be familiar with Processing IoT data for data analytics
4. To identify applications that makes use of multimedia Big Data and IoT
5. To implement smart systems using IoT

UNIT I BIG DATA INTEGRATION FOR IOT ANALYTICS 9

Introduction to IoT data and Big data – Challenges of IoT analytics applications – IoT analytics life cycle and techniques –Searching the Internet of Things: Introduction - Search Architecture for Social and Physical Sensors - Local Event Retrieval - Using Sensor Metadata Streams to Identify Topics of Local Events in the City – Venue Recommendation.

UNIT II IOT SEMANTICS AND DATA STREAMING ANALYTICS 9

Introduction – Linking data - Real-time & Linked Stream Processing - Semantic-based Distributed Reasoning - Cross-Domain Recommender Systems - Semantic Analytics - Semantic Modelling and Validation Tools - Data Reasoning - Ethical IoT

UNIT III PROCESSING OF IOT BIG DATA 9

Apache Hadoop, Employing Hadoop Map Reduce - Creating the components of Hadoop Map Reduce jobs - Distributing data processing across server farms –Executing Hadoop Map Reduce jobs - Monitoring the progress of job flows.

UNIT IV MULTIMEDIA BIGDATA COMPUTING FOR IOT 9

Introduction - Definition and Characteristics – Relationship between IoT and Multimedia Big Data (MMBD) – Multimedia Big Data Life Cycle - MMBD for IoT Applications - Data Collection – Technologies used - Analysis of Various Techniques - Opportunities, Issues, and Challenges .

UNITV CASE STUDIES OF IOT DATA ANALYTICS 9

Precision Agriculture and its Cyber-Physical Management, IoT implementation for smart cities and future Challenges, IoT based Intelligent Transportation System for Global Perspective, IoT based implementations for smart buildings.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end ofthe course thestudentswouldbeableto

CO1: Integrate big data and IoT for IoT analytics
CO2: Process IoT real-time and linked stream data.
CO3: Process and handle IoT Big data using Apache Hadoop
CO4: Work with multimedia Big Data and IoT
CO5: Design and implement smart IoT systems with big data
CO6: Implement smart systems using IOT application

TEXT BOOKS:

1. John Soldatos, "Building Blocks for IoT Analytics", River Publishers Series In Signal, Image and Speech Processing, 2017.
2. Sudeep Tanwar, Sudhanshu Tyagi, Neeraj Kumar, "Multimedia Big Data Computing for IoT Applications:Concepts, Paradigms and Solutions", Springer, 2020

REFERENCE BOOKS:

1. Valentina E. Balas, Vijender Kumar Solanki, Raghvendra Kumar, ManjuKhari, "Internet of Things and Big Data Analytics for Smart Generation", Volume 154.
2. Stackowiak, R., Licht, A., Mantha, V., Nagode, L.," Big Data and The Internet of Things Enterprise Information Architecture for A New Age", Apress, 2015.
3. Andrew Minteer, "Analytics for the Internet of Things (IoT): Intelligent analytics for your intelligent devices", Packt Publishing, first edition, July 2017.
4. Nilanjan Dey, Aboul Ella Hassanien, Chintan Bhatt, Amira S. Ashour, Suresh Chandra Satapathy, "Internet of Things and Big Data Analytics Toward Next-Generation Intelligence", Springer International Publishing, 2018.

U23EEV66	ARCHITECTING SMART IOT DEVICES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To Get acquainted with different smart devices and smart meters
2. To Describe how modern power distribution system functions
3. To Identify suitable communication networks for Smart Grid applications
4. To Learn the Concept of EMS
5. To provide knowledge on Distribution management system

UNIT I INTRODUCTION TO SMART GRID 9

Introduction - Evolution of Electric Grid, Smart Grid Concept - Definitions and Need for Smart Grid – Functions – Opportunities – Benefits and challenges, Difference between conventional & Smart Grid, Technology Drivers

UNIT II ENERGY MANAGEMENT SYSTEM 9

Energy Management System (EMS) - Smart substations - Substation Automation – Feeder Automation, SCADA – Remote Terminal Unit – Intelligent Electronic Devices – Protocols, Phasor Measurement Unit – Wide area monitoring protection and control, Smart integration of energy resources – Renewable, intermittent power sources – Energy Storage.

UNIT III DISTRIBUTION MANAGEMENT SYSTEM 9

Distribution Management System (DMS) – Volt / VAR control – Fault Detection, Isolation and Service Restoration, Network Reconfiguration, Outage management System, Customer Information System, Geographical Information System, Effect of Plug in Hybrid Electric Vehicles

UNIT IV SMART METERS 9

Introduction to Smart Meters – Advanced Metering infrastructure (AMI), AMI protocols – Standards and initiatives, Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNITV COMMUNICATION NETWORKS & IOT 9

Elements of communication and networking – architectures, standards, PLC, Zigbee, GSM, BPL, 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, Cyber Security for Smart Grid.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end ofthe course thestudentswouldbeableto

CO1: Learn the basic concepts of Smart Grid
CO2: Understand the contribution of Energy Management System
CO3: Know the importance of Distribution Management System
CO4: Understand the working of Smart meters
CO5: Learn the Concepts of Communication networks and IOT
CO6: Implement smart IOT devices to application

TEXT BOOKS:

1. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012

REFERENCE BOOKS:

1. Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015
2. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014.

VERTICAL VII ADVANCED CONTROL

		L	T	P	C
U23EEV71	**MODEL BASED CONTROL**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To introduce the Knowledge about Multivariable and Multiloop systems.
2. To understand the Model predictive control schemes and its elements.
3. To Get exposed to state space MPC along with case studies.
4. To acquire knowledge on various constrained MPC.
5. To make the student understand the principles of STR, MRAC and Gain scheduling.
6. To make the student design simple adaptive controllers for linear systems

UNIT I INTRODUCTION TO MIMO CONTROL 9

Introduction to MIMO Systems-Multivariable control-Multiloop Control-Multivariable IMC-IMCPID Case Studies.

UNIT II MODEL PREDICTIVE CONTROL SCHEMES 9

Introduction to Model Predictive Control - Model Predictive Control Elements – GeneralizedPredictive Control Scheme – Multivariable Generalized Predictive Control Scheme – MultipleModel based Model Predictive Control Scheme Case Studies

UNIT III STATE SPACE BASED MODEL PREDICTIVE CONTROL SCHEME 9

State Space Model Based Predictive Control Scheme - Review of Kalman Update based filters – State Observer Based Model Predictive Control Schemes – Case Studies

UNIT IV CONSTRAINED MODEL PREDICTIVE CONTROL SCHEME 9

Constraints Handling: Amplitude Constraints and Rate Constraints –Constraints and Optimization– Constrained Model Predictive Control Scheme – Case Studies.

UNITV ADAPTIVE CONTROL SCHEME 9

Introduction to Adaptive Control-Gain Scheduling-Self tuning regulators–MARS-Adaptive Model Predictive Control Scheme –Case Studies

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Ability to apply engineering knowledge to understand the control schemes on MIMOsystems.
CO2:	Ability to design controller for MIMO system.
CO3:	Ability to analyze the control schemes available in industries.
CO4:	Ability to design MPC, Adaptive controllers for practical engineering problems.
CO5:	Ability to analyze MARS technique.
CO6:	Ability to choose suitable controllers for the given problems.

TEXT BOOKS:

1. Coleman Brosilow, Babu Joseph, "Techniques of Model-Based Control", Prentice Hall PTR Pub 2002, 1st Edition.
2. E. F. Camacho, C. Bordons ,"Model Predictive Control",Springer-Verlag London Limited 2007, 2nd Edition.
3. K.J. Astrom and B. J. Wittenmark, "Adaptive Control", Second Edition, Pearson Education Inc., second Edition 2013.

REFERENCE BOOKS:

1. Paul Serban Agachi, Zoltan K. Nagy, Mircea Vasile Cristea, and Arpad Imre-Lucaci Model Based Control Case Studies in Process Engineering,WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim 2007.1st Edition.
2. Ridong Zhang, Anke Xue Furong Gao,"Model Predictive Control Approaches Based on the Extended State Space Model and Extended Non-minimal State Space Model",Springer Nature Singapore Pte Ltd. 2019, 1st Edition.
3. J.A. ROSSITER "Model-Based Predictive Control A Practical Approach"Taylor & Francis e-Library, 2005, 1st edition.

U23EEV72	NON LINEAR CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To provide knowledge on design in state variable form
2. To provide knowledge in phase plane analysis.
3. To give basic knowledge in describing function analysis.
4. To study the design of optimal controller.
5. To study the design of optimal estimator including Kalman Filter

UNIT I STATE VARIABLE DESIGN 9

Introduction to state Model- effect of state Feedback- Necessary and Sufficient Condition forArbitrary Pole-placement- pole placement Design- design of state Observers-separationprinciple- servo design: -State Feedback with integral control

UNIT II PHASE PLANE ANALYSIS 9

Features of linear and non-linear systems - Common physical non-linearities – Methods oflinearization Concept of phase portraits – Singular points – Limit cycles – Construction ofphaseportraits – Phase plane analysis of linear and non-linear systems – Isocline method.

UNIT III DESCRIBING FUNCTION ANALYSIS 9

Basic concepts, derivation of describing functions for common non-linearities – Describingfunction analysis of non-linear systems – limit cycles – Stability of oscillations.

UNIT IV OPTIMAL CONTROL 9

Introduction - Time varying optimal control – LQR steady state optimal control – Solution ofRicatti's equation – Application examples.

UNITV OPTIMAL ESTIMATION 9

Optimal estimation – KalmanBucy Filter-Solution by duality principle-Discrete systems-Kalman Filter-Application examples.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Able to apply the knowledge gained on state feedback control and nonlinear control.
CO2 :	Ability to carry out analysis for common nonlinearities in a system.
CO3:	Apply advanced control theory to practical engineering problems.
CO4:	Design optimal controller.
CO5:	Understand the basics and Importance of Kalman filter.
CO6:	Ability to choose suitable controllers for the given problems.

TEXT BOOKS:

1. G. J. Thaler, "Automatic Control Systems", Jaico Publishing House 1993.
2. M.Gopal, Modern Control System Theory, New Age International Publishers, 2002, 2nd 178
3. K. P. Mohandas, "Modern Control Engineering", Sanguine Technical Publishers, 2006, 1st

REFERENCE BOOKS:

1. Ashish Tewari, 'Modern Control Design with Matlab and Simulink', John Wiley, New Delhi, 2002, 1st Edition.
2. K. Ogata, 'Modern Control Engineering', 5th Edition, PHI, New Delhi, 2009.
3. T. Glad and L. Ljung,, "Control Theory –Multivariable and Non-Linear Methods", Taylor & Francis, 2002, 1st Edition.
4. D.S.Naidu, "Optimal Control Systems" First Indian Reprint, CRC Press, 2009, 1st Edition.
5. William S Levine, "Control System Fundamentals," The Control Handbook, CRC Press, Tayler and Francies Group, 2011, 2nd Edition.

U23EEV73	OPTIMAL CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To provide an exposure to different type of optimal control problems such as time-optimal, fuel optimal, energy optimal control problems.
2. To impart knowledge and skills needed to design Linear Quadratic Regulator for Time invariant and Time-varying Linear system (Continuous time and Discrete-time systems).
3. To introduce concepts needed to design optimal controller using Dynamic Programming Approach and H-J-B equation.
4. To provide an exposure to various types of fault tolerant control schemes such as Passive and active approaches.
5. To introduce concepts needed to design optimal controller in the presence of stateconstraints and time optimal controller.

UNIT I CALCULUS OF VARIATIONS AND OPTIMAL CONTROL 9

Introduction – Performance Index- Constraints – Formal statement of optimal control system– Calculus of variations – Function, Functional, Increment, Differential and variation and optimum of function and functional – The basic variation problem Extrema of functions and functional with conditions – variational approach to optimal control system

UNIT II LINEAR QUADRATIC OPTIMAL CONTROL SYSTEM 9

Problem formulation – Finite time Linear Quadratic regulator – Infinite time LQR system: TimeVarying case- Time-invariant case – Stability issues of Time-invariant regulator – LinearQuadratic Tracking system: Fine time case and Infinite time case.

UNIT III DISCRETE TIME OPTIMAL CONTROL SYSTEMS 9

Variational calculus for Discrete time systems – Discrete time optimal control systems:-Fixedfinal state and open-loop optimal control and Free-final state and open-loop optimalcontrol - Discrete time linear state regulator system – Steady state regulator system

UNIT IV PONTRYAGIN MINIMUM PRINCIPLE 9

Pontryagin Minimum Principle – Dynamic Programming:- Principle of optimality, optimalcontrol using Dynamic Programming – Optimal Control of Continuous time and Discrete-timesystems – Hamilton-Jacobi-Bellman Equation – LQR system using H-J-B equation.

UNITV CONSTRAINED OPTIMAL CONTROL SYSTEMS 9

Time optimal control systems – Fuel Optimal Control Systems- Energy Optimal ControlSystems – Optimal Control Systems with State Constraints.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Explain different type of optimal control problems such as time-optimal, fuel optimalenergy optimal control problems.
CO2 :	Design Linear Quadratic Regulator for Time-invariant and Time-varying Linear system(Continuous time and Discrete-time systems)
CO3:	Design optimal controller using Dynamic Programming Approach and H-J-B equation.
CO4:	Explain the Pontryagin Minimum Principle.

CO5: Design optimal controller in the presence of state constraints and time optimal controller.

CO6: Explain various types of fault tolerant control schemes such as Passiveand active approaches.

TEXT BOOKS:

1. Donald E. Kirk, Optimal Control Theory – An Introduction, Dover Publications, Inc. Mineola,New York, 2012, 10th Edition.
2. Yan Wang, Cheng-Lin Liu, Zhi-Cheng Ji, Quantitative Analysis and Optimal Control of Energy Efficiency in Discrete Manufacturing System, Springer, 2020, 1st Edition.

REFERENCE BOOKS:

1. D. Subbaram Naidu, Optimal Control Systems, CRC Press, New York, 2003, 1st Edition.
2. Frank L. Lewis, Draguna Vrabie, Vassilis L. Syrmos, Optimal Control, 3rd Edition, Wiley Publication, 2012, 3rd Edition.

		L	T	P	C
U23EEV74	**ADAPTIVE CONTROL**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To impart knowledge on how to recursively estimate the parameters of discrete input-output models using recursive parameter estimation methods
2. To make the student understand the principles of STR, MRAC and Gain scheduling.
3. To make the student design simple adaptive controllers for linear systems using STR.
4. To make design and MRAC and Gain scheduling.
5. To impart knowledge on Lyapunov theory & Relations between MRAS and STR.

UNIT I INTRODUCTION 9

Introduction - Adaptive Schemes - The adaptive Control Problem – Applications- Parameterestimation:-LS, RLS: and ERLS.

UNIT II GAIN SCHEDULING 9

Introduction- The principle - Design of gain scheduling controllers- Nonlinear transformations - application of gain scheduling - Auto-tuning techniques: Methods based on Relay feedback.

UNIT III DETERMINISTIC SELF-TUNING REGULATORS 9

Introduction- Pole Placement design - Indirect Self-tuning regulators - direct self-tuningregulators – Disturbances with known characteristics

UNIT IV STOCHASTIC AND PREDICTIVE SELF-TUNING REGULATORS 9

Introduction – Design of minimum variance controller - Design of moving average controller - stochastic self-tuning regulators

UNITV MODEL – REFERENCE ADAPTIVE SYSTEM 9

Introduction- MIT rule – Determination of adaptation gain - Lyapunov theory –Design ofMRAS using Lyapunov theory – Relations between MRAS and STR.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Ability to apply the estimation algorithm to estimate the parameters of the process.
CO2 :	Ability to apply the adaptive control concepts to control a process.
CO3:	Use appropriate software tools for design of adaptive controllers and analysis of the process.
CO4:	Identify, formulate, and carry out research by designing suitable adaptive schemes for complex instrumentation problem.
CO5:	Apply the concepts to design adaptive control for multidisciplinary problem.
CO6:	Ability to design MARS and STR.

TEXT BOOKS:

1. K.J. Astrom and B. J. Wittenmark, “Adaptive Control”, Second Edition, PearsonEducation Inc., second Edition 2013.
2. Lennart Ljung, “System Identification: Theory for the User”, Second Edition, Prentice Hall, 1999.

REFERENCE BOOKS:

1. T. Soderstorm and Petre Stoica, “System Identification”, Prentice Hall International(UK) Ltd., 1989, 1st Edition.

U23EEV75	COMPUTER CONTROL OF PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To represent the linear time invariant System in discrete State Space form
2. To analyze the controllability, observability and stability of a Discrete time System.
3. To estimate model parameters from input/output measurements
4. To Design Digital Controllers
5. To Design Multi-loop and Multivariable Controllers for multivariable system

UNIT I DISCRETE STATE-VARIABLE TECHNIQUE 9

State equation of discrete data system with sample and hold – State transition equation –Methods of computing the state transition matrix – Decomposition of discrete data transferfunctions – State diagrams of discrete data systems – System with zero-order hold –Controllability and observability of linear time invariant discrete data system–Stability tests ofDiscrete-data system.

UNIT II SYSTEM IDENTIFICATION 9

Identification of Non-Parametric Input-Output Models: -Transient analysis–Frequency analysis– Correlation analysis– Spectral analysis – Identification of Parametric Input-Output Models: - Least Squares Method – Recursive Least Square Method.

UNIT III DIGITAL CONTROLLER DESIGN 9

Review of z-transform – Modified of z-transform – Pulse transfer function – Digital PID controller– Dead-beat controller and Dahlin's controller – Kalman's algorithm, Pole Placement Controller.

UNIT IV MULTI-LOOP REGULATORY CONTROL 9

Multi-loop Control - Introduction – Process Interaction – Pairing of Inputs and Outputs – TheRelative Gain Array (RGA) – Properties and Application of RGA - Multi-loop PID Controller – Biggest Log Modulus Tuning Method – De-coupler.

UNITV MULTIVARIABLE REGULATORY CONTROL 9

Introduction to Multivariable control –Multivariable PID Controller – Multivariable Dynamic Matrix Controller – Case Studies: - Distillation Column, CSTR and Four-tank system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Develop mathematical models for discrete time systems using state variable techniques and analyze the stability of the system.
CO2:	Construct models from input-output data by least square and recursive least square method.
CO3:	Ability to design different digital controllers to satisfy the required criterion.
CO4:	Design a multi-loop controller and multivariable controller for multi-variable systems.
CO5:	Ability to design multivariable dynamic matrix controller for industrial processes.
CO6:	Ability to design multivariable regulatory control.

TEXT BOOKS:

1. Stephanopoulos, G., "Chemical Process Control -An Introduction to Theory and Practice", Prentice Hall of India, 1st Edition, 2015.
2. Sigurd Skogestad, Ian Postlethwaite, "Multivariable Feedback Control: Analysis and Design", John Wiley and Sons, 2005, 2nd Edition.

REFERENCE BOOKS:

1. Thomas E. Marlin, Process Control – Designing Processes and Control systems for Dynamic Performance, Mc-Graw-Hill,2000, 2nd Edition.
2. Gopal, M., "Digital Control and State Variable Methods", Tata Mc Graw Hill, 4th Edition, 2017.
3. P. Albertos and A. Sala, "Multivariable Control Systems An Engineering Approach", Springer Verlag, 1st Edition, 2004
4. Bequette, B.W., "Process Control Modelling, Design and Simulation", Prentice Hall of India, 1st Edition, 2003.
5. Dale E. Seborg, Duncan A. Mellichamp, Thomas F. Edgar, "Process Dynamics and Control", Wiley John and Sons, 4th Edition, 2016.

U23EEV76	MACHINE MONITORING SYSTEM	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To make the students familiarize with the concept of condition-based maintenance for effective utilization of machines.
2. To Impart the knowledge of artificial intelligence for machinery fault diagnosis.
3. To give basic knowledge on vibration monitoring.
4. To study the machinery vibrations using signal processing techniques.
5. To provide knowledge on FMECA.

UNIT I INTRODUCTION TO MACHINE CONDITION MONITORING 9

Machinery condition monitoring - Present status - Fault prognosis - Future needs.

UNIT II MACHINERY MAINTENANCE 9

Maintenance strategies – Reactive, Preventive, and Predictive – Benefits of plannedmaintenance – Bath tub curve – Failure Modes Effects and Criticality Analysis (FMECA).

UNIT III INTRODUCTION TO MACHINERY VIBRATION AND MONITORING 9

Characteristics of Vibration systems – Mode shapes & operational deflection shapes –Experimental modal analysis – Principles of vibration monitoring – Machinery faults diagnosedby vibration analysis.

UNIT IV SIGNAL PROCESSING IN MACHINERY MONITORING 9

FFT analysis – Time domain analysis – Time-frequency analysis – Signal filtering – Cepstrumanalysis – Health condition of compressor & engine.

UNITV MACHINE LEARNING FOR CONDITION MONITORING 9

Machine Learning: Feature extraction and feature selection methods – Feature reduction – Classification techniques – Case studies of condition monitoring in Nuclear plant components, Distillation column.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Ability to identify the faults in machinery.

CO2: Choose the proper maintenance strategies and condition monitoring techniques for identification of failure in a machine.

CO3: Construct a classifier model for machine learning based fault diagnosis.

CO4: Predict the faulty component in a machine by analyzing the acquired vibration signals.

CO5: Ability to explain condition monitoring in nuclear plant components.

CO6: Ability to analyze & build a model using modern tools.

TEXT BOOKS:

1. Cornelius SchefferandPareshGirdhar, "Practical Machinery Vibration Analysis and Predictive Maintenance", Elsevier, 2004, 1st Edition.
2. A. R. Mohanty, "Machinery Condition Monitoring: Principles and Practices" , CRC Press, Taylor & Francis, 1st Edition, 2017.

REFERENCE BOOKS:

1. Stephen Marsland, Machine Learning: An Algorithmic Perspective, 2nd Edition, 2014, CRC, Press.
2. Collacot, "Mechanical Fault Diagnosis and Condition Monitoring", Chapman- Hall, 1st Edition, 2011.
3. Davies, "Handbook of Condition Monitoring – Techniques and Methodology", Springer, 1st Edition, 2011.
4. Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Elsevier, 3rd Edition 2011.
5. Ferdinand van der Heijden, Robert Duin, Dick de Ridder, David M. J. Tax, Classification, Parameter Estimation and State Estimation: An Engineering Approach Using MATLAB, John Wiley & Sons, 2nd Edition, 2017.

VERTICAL VIII DIVERSIFIED COURSES

		L	T	P	C
U23EEV81	**HYBRID ENERGY TECHNOLOGY**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To provide knowledge about different types of hybrid energy systems.
2. To analyze the various electrical Generators used for the Wind Energy Conversion Systems.
3. To design the power converters used in SPV Systems.
4. To analyze 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.
5. To analyze the performance of the various hybrid energy systems

UNIT I INTRODUCTION TO HYBRID ENERGY SYSTEMS 9

Hybrid Energy Systems – Need for Hybrid Energy Systems – Solar-Wind-Fuel Cell-Diesel, Wind-Biomass-Diesel, Micro-Hydel-PV, Ocean and geyser energy - Classification of Hybrid Energy systems –Importance of Hybrid Energy systems – Advantages and Disadvantages - Environmental aspects ofrenewable energy - Impacts of renewable energy generation on the environment - Present Indian andinternational energy scenario of conventional and RE sources - Ocean energy, Hydel Energy – WindEnergy, Biomass energy, Hydrogen energy – SolarPhotovoltaic (PV) and Fuel cells: Operatingprinciples and characteristics.

UNIT II ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS (WECS) 9

Review of reference theory fundamentals –Construction, Principle of operation and analysis: SquirrelCage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) - Permanent MagnetSynchronous 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 buckboostconverters- selection of inverter, battery sizing, array sizing - Analysis of SPV Systems – Blockdiagram 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: uncontrolledrectifiers, PWM Inverters - Bi-Directional Converters - Grid-Interactive Inverters - Matrix converter –Merits and Limitations.

UNITV CASE STUDIES FOR HYBRID RENEWABLE ENERGY SYSTEMS 9

Hybrid Systems- Range and type of Hybrid systems – Performance Analysis – Cost Analysis – Casestudies of Diesel-PV, Wind-PV-Fuel-cell, Micro-hydel-PV, Biomass-Diesel-Fuel-cell systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end ofthe course thestudentswouldbeableto

CO1:	Analyze the impacts of hybrid energy technologies on the environment and demonstrate them to harness electrical power.
CO2:	Select a suitable Electrical machine for Wind Energy Conversion Systems and simulatewind energy conversion system
CO3:	Design the power converters such as AC-DC, DC-DC, and AC-AC converters forSPV systems.
CO4:	Analyze the power converters such as AC-DC, DC-DC, and AC-AC converters forHybrid energy systems.
CO5:	Interpret the hybrid renewable energy systems.
CO6:	Analyze the performance of the various hybrid energy systems.

TEXT BOOKS:

1. Bahman Zohuri, “Hybrid Energy Systems”, Springer, First Edition, 2018.
2. S.M. Muyeen, “Wind Energy Conversion Systems”, Springer First Edition, 2012
3. Md. Rabiul Islam, Md. Rakibuzzaman Shah, Mohd Hasan Ali, "Emerging Power Converters forRenewable Energy and Electric Vehicles", CRC Press, First Edison, 2021

REFERENCE BOOKS:

1. Ernst Joshua, Wind Energy Technology, PHI, India, 2018, 3rd Edition.
2. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 7thImpression, 2005
3. Rashid.M. H “Power electronics Hand book”, Academic press,4th Edition, 2018.
4. Rai. G.D, “Non-conventional energy sources”, Khanna publishers, 6th Edition, 2017.
5. Rai. G.D, “Solar energy utilization”, Khanna publishers, 3rd Edition, 1987.
6. Gray, L. Johnson, “Wind energy system”, Prentice Hall of India, 2nd Edition, 2006.
7. B.H.Khan "Non-conventional Energy sources", Tata McGraw hill Publishing Company, New Delhi,2017, 3rd Edition.

U23EEV82	ENERGY STORAGE SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To understand the various types of energy storage Technologies.
2. To analyze thermal storage system.
3. To analyze different battery storage technologies
4. To analyze the thermodynamics of Fuel Cell
5. To study the various applications of energy storage systems.

UNIT I INTRODUCTION **9**

Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications.

UNIT II THERMAL STORAGE SYSTEM **9**

Thermal storage – Types – Modeling of thermal storage units – Simple water and rock bed storage system – pressurized water storage system – Modelling of phase change storage system – Simple units, packed bed storage units - Modelling using porous medium approach, Use ofTRNSYS.

UNIT III ELECTRICAL ENERGY STORAGE **9**

Fundamental concept of batteries – measuring of battery performance, charging and discharging, power density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel – Cadmium, Zinc Manganese dioxide, Li-ion batteries - Mathematical Modelling for Lead Acid Batteries – Flow Batteries.

UNIT IV FUEL CELL **9**

Fuel Cell – History of Fuel cell, Principles of Electrochemical storage – Types – Hydrogen oxygencells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis – advantages anddisadvantages.

UNITV ALTERNATE ENERGY STORAGE TECHNOLOGIES **9**

Flywheel, Super capacitors, Principles & Methods – Applications, Compressed air Energy storage,Concept of Hybrid Storage – Applications, Pumped Hydro Storage – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end ofthe course thestudentswouldbeableto

CO1: Understand different types storage technologies
CO2: Design a thermal storage system
CO3: Model battery storage system
CO4: Analyze the thermodynamics of fuel cell
CO5: Analyze the appropriate storage technologies for different applications
CO6: Analyze the performance of fuel cell and different storages systems.

TEXT BOOKS:

1. Ibrahim Dincer and Mark A. Rosen, 'Thermal Energy Storage Systems and Applications', John Wiley & Sons, 3rd Edition, 2021.
2. Ru-shi Liu, Lei Zhang and Xueliang sun, 'Electrochemical technologies for energy storage and conversion', Wiley publications, 2nd Volume set, 2012.
3. James Larminie and Andrew Dicks, 'Fuel cell systems Explained', Wiley publications, 3rd Edition, 2018.

REFERENCE BOOKS:

1. Lunardini.V.J, 'Heat Transfer in Cold Climates', John Wiley and Sons 1981, 1st Edition.
2. Schmidt.F.W. and Willmott.A.J., 'Thermal Energy Storage and Regeneration',Hemisphere Publishing Corporation, 1981, 1st Edition.

U23EEV83	SUSTAINABLE AND ENVIRONMENTAL FRIENDLY HV INSULATION SYSTEM	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To Know about the products related with sustainable applicaton.
2. To learn about Green Gaseous insulators.
3. To learn about liquid solid insulators.
4. To learn about testing of insulators.
5. To understand the standards for green insulation systems.

UNIT I SUSTAINABLE AND ENVIRONMENTAL ENERGY AND PRODUCTS 9

Carbon print, global warming potential, environment requirement for any product and system.

UNIT II ALTERNATE GREEN GASEOUS INSULATORS 9

SF6 gas and its hazardous environmental effects, alternate gases, gaseous mixtures and other sources and it's properties.

UNIT III ALTERNATE GREEN LIQUID INSULATORS 9

hazardous effects of existing liquid dielectric materials (such as organic oil), alternate sources of environmental friendly liquid such as ester oil, vegetable oils dielectric and it's properties.

UNIT IV ALTERNATE GREEN SOLID INSULATORS 9

hazardous effects of existing solid dielectric materials, alternate sources of environmental friendlysolid dielectric and its properties.

UNITV EVOLVING STANDARDS FOR GREEN INSULATION SYSTEMS 9

Requirements, evolving standards of management, testing, usage and disposal of alternate insulation systems, Major applications and standards.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end ofthe course thestudentswouldbeableto

CO1: Know about environmental energy and products.
CO2: Know about sustainable energy and products.
CO3: Describe the alternate green gaseous insulators.
CO4: Describe the alternate green liquid insulators
CO5: Describe the alternate green solid insulators
CO6: Elaborate the standards for Green insulation systems.

TEXT BOOKS:

1. https://www.iec.ch/sdgs/sdg13
2. http://highperformanceinsulation.eu/wp- content/uploads/ 2016/08/ sustainability_a_guide.pdf

REFERENCE BOOKS:

1. https://www.iso.org/standard/79064.html
2. https://www.ictfootprint.eu/en/iec-tr-627252013-factsheet
3. https://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID,FSP_LANG_ID:1275,25
4. https://www.iec.ch/ords/f?p=103:41:628762356646470::::FSP_ORG_ID,FSP_LANG_ID:3237, 25
5. https://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID,FSP_LANG_ID:1299,25

U23EEV84	GRID INTEGRATING TECHNIQUES AND CHALLENGES	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To study about the present power Scenario
2. To model a micro grid system
3. To model power converter for grid interconnection
4. To integrate wind energy conversion system with grid
5. To simulate power converters like three phase inverters and DC-DC converters

UNIT I PRESENT POWER SCENARIO IN INDIA 9

Introduction - Thermal Power Plant , Components of Thermal Power Plant , Major Thermal PowerPlants in India- Gas-Based Power Generation - Nuclear Power Plants -Hydropower Generation -Pumped Storage Plants - Solar Power - Wind Energy – Power plants India

UNIT II POWER GRIDS 9

Introduction -Electric Power ,Background , The Construction of a Power Grid System , Basic Concepts of Power Grids -Load Models - Transformers in Electric Power Grids - Modelling a MicrogridSystem.

UNIT III MODELING OF CONVERTERS IN POWER GRID DISTRIBUTED GENERATION SYSTEMS 9

Introduction - Single-Phase DC/AC Inverters with Two Switches, Three-Phase DC/AC Inverters, PulseWidth Modulation Methods, The Triangular, The Identity Method, Analysis of DC/AC Three-PhaseInverters. Micro grid of Renewable Energy Systems- DC/DC Converters in Green Energy - Pulse WidthModulation -Sizing of an Inverter for Microgrid Operation, Sizing of a Rectifier for Microgrid Operation,The Sizing of DC/DC Converters for Micro grid

UNIT IV WIND ENERGY SYSTEM GRID INTEGRATION 9

Introduction- Significance of Electrical Power Quality in Wind Power System- Integration Issues inGrid-Connected Wind Energy- Effect of Power Quality Issues, Importance of Custom Power Devices- Power Quality Point of View.

UNITV GRID INTER CONNECTION 9

Grid Code requirements-Grid integration of WECS-Grid Integration of PV system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end ofthe course thestudentswouldbeableto

CO1: Review the power sector scenario in India.
CO2: Model a microgrid system
CO3: Model a converter for power grid distributed system.
CO4: Integrate wind energy system.
CO5: Simulate three phase inverter with fixed and sine PWM.
CO6: Ability to explain Power Quality issues.

TEXT BOOKS:

1. Brian D'Andrade "The Power Grid", Academic Press, 1st Edition, 2017.
2. Yang Han, "Modeling and Control of Power Electronic Converters for Microgrid Applications",Springer, 1st Edition 2022.
3. Siegfried Heier, "Grid Integration of Wind Energy: Onshore and Offshore Conversion Systems",John Wiley & Sons, Ltd, 2014, 3rd Edition.

REFERENCE BOOKS:

1. Integration of Renewable Energy Sources with Smart Grid, M. Kathiresh, A. Mahaboob Subahani,and G.R. Kanaga chidambaresan, Scrivener & Wiley, 2021, 1st Edition.
2. Control and Operation of Grid-Connected Wind Energy Systems, Ali M. Eltamaly, Almoataz Y.Abdelaziz, Ahmed G. Abo-Khalil, Springer 2021, 1st Edition.
3. Design of smart power grid renewable energy systems, Third Edition, Ali Keyhani, Wiley 2019.
4. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, Wiley 2017, 1st Edition.
5. Fundamentals of Power Electronics with MATLAB, Randall Shaffer, Laxmi publications, 2013, 2nd Edition.
6. Power Conversion and Control of Wind Energy Systems, Bin Wu, 2011, Wiley-IEEE, 1st Edition.
7. Wind Power Integration - Connection and System Operational Aspects, Brendan Fox, 2014, IET, 2nd Edition.
8. Renewable Energy Devices and Systems with Simulations in MATLAB and ANSYS, Frede Blaabjerg,Dan M. Ionel, CRC press, 2017, 1st Edition.

U23EEV85	DESIGN AND MODELLING OF RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To review the renewable energy systems and technology
2. To learn the Single phase grid-connected photovoltaic systems and three phase photovoltaic systems
3. To learn Permanent Magnet Synchronous Generators for Small Wind Power Applications
4. To illustrate the small wind energy systems
5. To simulate the Doubly-fed induction generator based WECS

UNIT I RENEWABLE ENERGY SYSTEMS: TECHNOLOGY OVERVIEW ANDPERSPECTIVES 9

Introduction-State of the Art- Examples of Recent Research and Development Challenges andFuture Trends.

UNIT II SINGLE-PHASE GRID-CONNECTED PHOTOVOLTAIC SYSTEMS 9

Introduction- Demands for Grid-Connected PV Systems-Power Converter Technology for Single-Phase PV Systems, Transformer less AC-Module Inverters (Module-Integrated PV Converters,Transformer less Single-Stage String Inverters, DC-Module Converters in Transformer lessDouble-Stage PV Systems.

UNIT III THREE-PHASE PHOTOVOLTAIC SYSTEMS: STRUCTURES,TOPOLOGIES 9

Introduction-PV Inverter Structures, Three-Phase PV Inverter Topologies- -Control Building Blocksfor PV Inverters, Modulation Strategies for Three-Phase PV Inverters, Implementation of theModulation Strategies., Grid Synchronization, Implementation of the PLLs for GridSynchronization,Current Control, Implementation of the Current Controllers, Maximum Power Point Tracking.

UNIT IV SMALL WIND ENERGY SYSTEMS 9

Introduction-Generator Selection for Small-Scale Wind Energy Systems- Turbine Selection for Wind Energy- Self-Excited Induction Generators for Small Wind Energy Applications-PermanentMagnet Synchronous Generators for Small Wind Power Applications- Grid-Tied Small WindTurbine Systems-Magnus Turbine–Based Wind Energy System

UNITV DOUBLY-FED INDUCTION GENERATOR-BASED WECS 9

Introduction – modelling of induction machine in machine variable form and arbitrary referenceframe, modelling of Doubly-fed Induction Generator.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end ofthe course the students would be able to

CO1: Review the perspectives of renewable energy systems
CO2: Integrate photovoltaic systems with grid
CO3: Study inverter for PV systems
CO4: Elaborate the working of small wind power systems
CO5: Study the features of induction machine and doubly fed induction machine

CO6: To make a design on DFIG and PMSG wind energy conversion systems.

TEXT BOOKS:

1. Ahmad Azar, Nashwa Kamal, "Design, Analysis and Applications of Renewable Energy Systems", Academic Press, First Edition, 2021
2. Ahmad Azar, Nashwa Kamal, "Renewable Energy Systems", Academic Press, First Edition, 2021
3. Nabil Derbel, Quanmin ZhuModeling, "Identification and Control Methods in Renewable EnergySystems" , Springer, First Edition, 2019

REFERENCE BOOKS:

1. Power Conversion and Control of Wind Energy Systems, Bin Wu, 2011, Wiley-IEEE, 1st Edition.
2. Wind Electrical Systems, S.N. Bhadra, 2005, Oxford, 7th Impression.
3. Wind Power Integration - Connection and System Operational Aspects, Brendan Fox, 2014, IET, 2nd Edition.
4. Renewable Energy Devices and Systems with Simulations in MATLAB and ANSYS,Frede Blaabjerg, Dan M. Ionel, CRC press, 2017, 1st Edition.

U23EEV86	PLC PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To know about the basics of PLC and Automation
2. To understand the importance of Automation
3. To explore various types and manufactures of PLCs.
4. To introduce types of programming languages of PLC and some exercise few programs.
5. To learn VPLC programming.

UNIT I INTRODUCTION 9

Programmable Logic Controller (PLC)- Block diagram of PLC- Programming languages of PLC Basic instruction sets- Design of alarm and interlocks- Networking of PLC- Overview of safety of PLC with case studies- Process Safety Automation: Levels of process safety through use of PLCs- IEC 61131-3 Standard - Application of international standards in process safety control

UNIT II IEC 61131-3 9

Rails- Rungs- Relay Logic- Latch switch- Timers- Counters- Boolean logics- Math Instructions- Data manipulation Instructions- Requirement of communication networks for PLC, PLC to PCCommunication to computer- FBD equivalent to LL- FBD Programming- IL- SFC-ST.

UNIT III SCADA 9

Elements of SCADA system- History of SCADA, Remote Terminal Unit- Discrete control- Analogcontrol, Master Terminal Unit- Operator interface.

UNIT IV HART AND FIELD BUS 9

Introduction- Evolution of signal standards- HART communication protocol- communicationmodes- HART networks- HART commands- HART and OSI model- Field bus- Architecture- Basic requirements of field Bus standard- Field bus Topology- Interoperability- Interchangeability.

UNITV PLC PROGRAMMING 9

Exercise in Programming Languages from IEC 61131-3: Traffic Light Control- Two way- Fourway – Water Level Control- Automatic Material Sorting System- Automatic Bottle Filling System,Code Converters- DC motor Control- Alarm Circuit.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end ofthe course thestudentswouldbeableto

CO1:	Understand the basics and need for Automation in industries.
CO2:	Explain the logic and flow of any particular programming written for a process.
CO3:	Apply the knowledge to design or improve an existing program to increase productivity of anyprocess.
CO4:	Breakdown SCADA architecture and communication protocols.
CO5:	Build and logic in any of the programming languages from IEC- 61131- 3 standards.
CO6:	Explain VPLC programming Concept.

TEXT BOOKS:

1. Bolton. W, “Programmble Logic Controllers”, Elsevier Newnes, 6th Edition 2015.
2. Frank D. Petruzella, “Programmable Logic Controllers”, 5th Edition, McGraw- Hill, New York,2019.

REFERENCE BOOKS:

1. Jay Hooper, “Introduction to PLCs”, Carolina Academic Press; 2nd Edition 2006.
2. https://new.siemens.com/global/en/products/automation/systems/industrial/plc/logo/logosoftware.htm
3. https://componentsearchengine.com/library/proteus?gclid=CjwKCAjw_ISWBhBkEiwAdqxb9okU2ZZHcQoa9fSRK2Uq41Rq0GZxdGUP6_6GlBv77p4JqGt_iDAljhoCksEQAvD_Bw

OPEN ELECTIVE I

U23MEV36	RENEWABLE ENERGY TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. ToknowtheIndianandglobalenergyscenario
2. Tolearnthevarioussolarenergytechnologiesanditsapplications.
3. Toeducatethevariouswindenergytechnologies.
4. Toexplorethevariousbio-energytechnologies.
5. Tostudytheoceanandgeothermaltechnologies.

UNIT I ENERGY SCENARIO 9

Indian energy scenario in various sectors — domestic, industrial, commercial, agriculture,transportation and others — Present conventional energy status — Present renewable energystatus-Potential of various renewable energy sources-Global energy status-Per capita energyconsumption-Futureenergyplans.

UNIT II SOLARENERGY 9

Solarradiation–Measurementsofsolarradiationandsunshine–Solarspectrum-Solarthermalcollectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermalenergystorage–Fundamentalsofsolarphotovoltaicconversion–Solarcells–SolarPVSystems--SolarPVapplications.

UNIT III WINDENERGY 9

Wind data and energy estimation – Betz limit - Site selection for wind farms – characteristics - Windresourceassessment-Horizontalaxiswindturbine–components-Verticalaxiswindturbine–Wind turbine generators and its performance – Hybrid systems – Environmental issues -Applications.

UNIT IV BIO-ENERGY 9

Bioresources— Biomassdirectcombustion— thermo chemicalconversion-biochemicalconversion-mechanical conversion-Biomassgasifier-Typesofbiomassgasifiers–Cogeneration -- Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.

UNITV OCEAN AND GEOTHERMAL ENERGY 9

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: DiscusstheIndianandglobalenergyscenario.
CO2: Describethevarioussolarenergytechnologiesanditsapplications.
CO3: Explainthevariouswindenergytechnologies.
CO4: Explorethevariousbio-energytechnologies
CO5: Discusstheoceanandgeothermaltechnologies.
CO6: Implement the renewable energy resources to the real time application

TEXT BOOKS:

1. Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636
2. Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707

REFERENCE BOOKS:

1. GodfreyBoyle,"RenewableEnergy,PowerforaSustainableFuture",OxfordUniversityPress, U.K.,2012
2. Rai.G.D.,"Non-ConventionalEnergySources",KhannaPublishers,NewDelhi,2014.
3. Sukhatme.S.P.,"SolarEnergy:PrinciplesofThermalCollectionandStorage",TataMc GrawHill Publishing CompanyLtd.,NewDelhi,2009.
4. TiwariG.N.,"SolarEnergy— FundamentalsDesign,Modellingandapplications",AlphaScienceIntlLtd,2015
5. Twidell,J.W.&WeirA.,"RenewableEnergyResources",EFNSponLtd.,UK,2015

U23EEO12	ELECTRIC AND HYBRID VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To know the need of Electric vehicle
2. To learn the various sources of energy and its applications.
3. To educate the various motors and drives technologies.
4. To explore the various power converters and controllers.
5. To study the hybrid and electric vehicles

UNIT I DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES 9

Need for Electric vehicle- Comparative study ofdiesel,petrol, hybrid and electric Vehicles.Advantages and Limitations of hybrid and electric Vehicles.- Design requirement for electricvehicles

Range,maximumvelocity,acceleration,powerrequirement,massofthevehicle.Various Resistance-Transmission efficiency- Electric vehicle chassis and Body Design, ElectricVehicleRecharging andRefuelling Systems.

UNIT II ENERGY SOURCES 9

Battery Parameters- - Different types of batteries — Lead Acid- Nickel Metal Hydride - Lithium ion- Sodiumbased-MetalAir.BatteryModelling-Equivalentcircuits,Batterycharging-QuickCharging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell.Ultra capacitors - BatteryManagement System

UNIT III MOTORSAND DRIVES 9

Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, Switched reluctancemotorsworkingprinciple, constructionandcharacteristics

UNIT IV POWER CONVERTERS AND CONTROLLERS 9

Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC -Power Converters — rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSMmotors,BLDCmotors,Switched reluctancemotors–fourquadrant operations – operatingmodes

UNITV HYBRID AND ELECTRIC VEHICLES 9

Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Understand the operation and architecture of electric and hybrid vehicles
CO2:	Identify various energy source options like battery and fuel cell.
CO3:	Select suitable electric motor for applications in hybrid and electric vehicles.
CO4:	Explain the role of power electronics in hybrid and electric vehicles
CO5:	Analyze the energy and design requirement for hybrid and electric vehicles
CO6:	Implement various techniques of hybrid and electric vehicles to real time application

TEXT BOOKS:

1. Iqbal Husain,"ElectricandHybridVehicles-DesignFundamentals",CRCPress,2003
2. Mehrdad Ehsani,"ModernElectric,HybridElectricandFuelCellVehicles",CRCPress,2005.

REFERENCE BOOKS:

1. JamesLarminieandJohnLowry,"ElectricVehicleTechnologyExplained"JohnWiley &Sons,2003
2. Lino Guzzella,"VehiclePropulsionSystem"SpringerPublications,2005
3. RonHodKinson,"LightWeightElectric/HybridVehicleDesign",ButterworthHeinemannPublication,2005.

U23EEO13	ENERGY CONSERVATION AND MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. understandandanalysetheenergydataofindustries
2. carryoutenergyaccountingandbalancing
3. conductenergyauditandsuggestmethodologiesforenergysavingsand
4. utilisetheavailableresourcesinoptimalways
5. Implement various energy conservation techniques to real time application

UNIT I INTRODUCTION 9

Energy- Power–Past&PresentscenarioofWorld;NationalEnergyconsumptionData–Environmental aspects associated with energy utilization – Energy Auditing: Need, Types,MethodologyandBarriers.RoleofEnergyManagers.Instrumentsforenergyauditing.

UNIT II ELECTRICALSYSTEMS 9

Components of EB billing ― HT and LT supply, Transformers, Cable Sizing, Concept ofCapacitors,PowerFactorImprovement,Harmonics,ElectricMotors-MotorEfficiencyComputation, Energy Efficient Motors, Illumination ― Lux, Lumens, Types of lighting,Efficacy,LEDLightingandscopeofEnconinIllumination

UNIT III THERMALSYSTEMS 9

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation andencon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, FlashSteamUtilization,Insulators&Refractories

UNIT IV ENERGYCONSERVATIONINMAJORUTILITIES 9

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air ConditioningSystems–CoolingTowers –D.G. sets

UNITV ECONOMICS 9

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net PresentValue,LifeCycleCosting–ESCOconcept

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Remember the knowledge for Basic combustion and furnace design and selection of thermal and mechanical energy equipment.
CO2:	Study the Importance of Stoichiometry relations, Theoretical air required for complete combustion.
CO3:	Skills on combustion thermodynamics and kinetics
CO4:	Apply calculation and design tube still heaters.
CO5:	Studied different heat treatment furnace
CO6:	Practical and theoretical knowledge burner design.

TEXT BOOKS:

1. Energy Manager Training Manual (4 Volumes) available at www.energymanagertraining.com. a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.
2. Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 1987

REFERENCE BOOKS:

1. Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management And Utilisation" Hemisphere Publ, Washington, 1988.
2. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
3. Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, 1982
4. Turner. W.C., "Energy Management Hand book", Wiley, New York, 1982.

U23ECO12	FUNDAMENTALS OF ELECTRONIC DEVICES AND CIRCUITS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Togiveacomprehensiveexposuretoalltypesofdevicesandcircuitsconstructedwithdiscretecomponents.Thishelpstodevelopastrongbasisforbuildinglinearanddigital integratedcircuits
2. Toanalyzethefrequencyresponseofsmallsignalamplifiers
3. Todesignandanalyzesinglestageandmultistageamplifiercircuits
4. Tostudyaboutfeedbackamplifiersandoscillatorsprinciples
5. Tounderstandtheanalysisanddesignofmultivibrators

UNIT I SEMICONDUCTORDEVICES **9**

PN junction diode, Zener diode, BJT, MOSFET, UJT –structure, operation and V-I characteristics,Rectifiers–HalfWaveandFullWaveRectifier,Zenerasregulator.

UNIT II AMPLIFIERS **9**

Load line, operating point, biasing methods for BJT and MOSFET**,** BJT small signal model **—**Analysis of CE, CB, CC amplifiers- Gain and frequency response –Analysis of CS and Sourcefollower–Gainandfrequencyresponse-Highfrequencyanalysis.

UNIT III MULTISTAGE AMPLIFIERSANDDIFFERENTIALAMPLIFIER **9**

Cascode amplifier, Differential amplifier – Common mode and Difference mode analysis – Tunedamplifiers–Gainandfrequencyresponse–Neutralizationmethods.

UNIT IV FEEDBACK AMPLIFIERS AND OSCILLATORS **9**

Advantages of negative feedback – Analysis of Voltage / Current, Series , Shunt feedbackAmplifiers – positive feedback–Condition for oscillations, phase shift – Wien bridge, Hartley, ColpittsandCrystaloscillators.

UNITV POWERAMPLIFIERSANDDC/DCCONVERTERS **9**

Power amplifiers- class A-Class B-Class AB-Class C-Temperature Effect- Class AB PoweramplifierusingMOSFET–DC/DCconvertors**—** Buck,Boost,Buck-Boost analysis anddesign.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Explain the structure and working operation of basic electronic devices.
CO2: Design and analyze amplifiers.
CO3: Analyze frequency response of BJT and MOSFET amplifiers
CO4: Design and analyze feedback amplifiers and oscillator principles
CO5: Design and analyze power amplifiers and supply circuits
CO6: Implement the electronics devices to real time application

TEXT BOOKS:

1. David A. Bell, "Electronic Devices and Circuits", Oxford Higher Education press, 5 th Edition, 2010
2. Robert L. Boylestad and Louis Nasheresky, “Electronic Devices and Circuit Theory”, 10th Edition, Pearson Education / PHI, 2008.
3. Adel .S. Sedra, Kenneth C. Smith, "Micro Electronic Circuits", Oxford University Press, 7th Edition, 2014

REFERENCE BOOKS:

1. Donald.A. Neamen, "Electronic Circuit Analysis and Design", Tata McGraw Hill, 3 rd Edition, 2010.
2. D.Schilling and C.Belove, "Electronic Circuits", McGraw Hill, 3 rd Edition, 1989
3. Muhammad H.Rashid, "Power Electronics", Pearson Education / PHI , 2004

U23EEO15	BATTERIES AND MANAGEMENT SYSTEM	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To understandandanalysethe battery management inindustries
2. Design and calculation of battery pack methods
3. Simulateand execute the battery modelling
4. Estimatetheavailableresourcesinbattery state
5. Implement various BMS architecture techniques to real time application

UNIT I ADVANCEDBATTERIES 9

Li-ion Batteries-different formats chemistry, safe operating area, efficiency, and aging. Characteristics- SOC, DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries-NCM and NCA Batteries. NCR18650B specifications.

UNIT II BATTERY PACK 9

Battery Pack- design, sizing, calculations, flow chart, real and simulation Model. Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging

UNIT III BATTERYMODELLING 9

Battery Modelling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models- Introduction. Battery Modelling software/simulation frameworks

UNIT IV BATTERYSTATEESTIMATION 9

SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods- Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms.

UNITV BMSARCHITECTUREANDREALTIMECOMPONENTS 9

Battery Management System- necessity, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray- CANedge1 package. ARBIN Battery Tester. BMS Development with Modeling software and Model- Based Design.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: AcquireknowledgeofdifferentLi-ionBatteriesperformance.
CO2: DesignaBatteryPackandmakerelatedcalculations.
CO3: DemonstrateaBattery ModelorSimulation.
CO4: EstimateState-of-ChargesinaBatteryPack.
CO5: ApproachdifferentBMSarchitecturesduringrealworldusage.
CO6: Use the batteries to real time application

TEXT BOOKS:

1. Jiuchun Jiang and Caiping Zhang, “Fundamentals and applications of Lithium-Ion batteriesin Electric Drive Vehicles’’, Wiley, 20105
2. Davide Andrea ,“Battery Management Systems for Large Lithium-Ion Battery Packs”

ARTECH House, 20105

REFERENCE BOOKS:

1. Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper
2. Panasonic NCR18650B- Data Sheet, bq76PL536A-Q1- IC Data Sheet, CC2662R-Q1- IC Data Sheet

OPEN ELECTIVE II

U23EEO21	AUTOMOTIVE ELECTRICAL AND ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Basic operation of measurement and sensors
2. Types of resistance and inductance sensors
3. Basic operation of special sensors
4. Working principles and construction of actuators
5. Sensor and actuators used in automotive vehicles.

UNIT I INTRODUCTION TO MEASUREMENTS AND SENSORS 9

Sensors: Functions- Classifications- Main technical requirement and trends Units and standards- Calibration methods- Classification of errors- Error analysis- Limiting error-Probable error- Propagation of error- Odds and uncertainty- principle of transduction-Classification. Static characteristics- mathematical model of transducers- Zero, First andSecond order transducers- Dynamic characteristics of first and second order transducers for standard test inputs.

UNIT II VARIABLE RESISTANCE AND INDUTANCE SENSORS 9

Principle of operation- Construction details- Characteristics and applications of resistivepotentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers:- EI pick up and LVDT

UNIT III VARIABLE AND OTHER SPECIAL SENSORS 9

Variable air gap type, variable area type and variable permittivity type- capacitor microphonePiezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers- Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.

UNIT IV AUTOMOTIVE ACTUATORS 9

Electromechanical actuators- Fluid-mechanical actuators- Electrical machines- Direct currentmachines- Three-phase machines- Single-phase alternating-current Machines - Duty-typeratings for electrical machines. Working principles, construction and location of actuators viz.Solenoid, relay, stepper motor etc.

UNITV AUTOMATIC TEMPERATURE CONTROL ACTUATORS 9

Different types of actuators used in automatic temperature control- Fixed and variabledisplacement temperature control- Semi Automatic- Controller design for Fixed and variabledisplacement type air conditioning system

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	List common types of sensor and actuators used in vehicles.
CO2:	Design measuring equipment's for the measurement of pressure force, temperature and flow.
CO3:	Generate new ideas in designing the sensors and actuators for automotive application.

CO4: Understand the operation of the sensors, actuators and electronic control.
CO5: Understand the operation of Electromechanical actuators
CO6: Design temperature control actuators for vehicles.

TEXT BOOKS:

1. Doebelins Measurement Systems: 7th Edition (SIE),Ernest O. Doebelin DhaneshN.Manik McGraw Hill Publishers, 2019.
2. Robert Brandy, " Automotive Electronics and Computer System", Prentice Hall,2001
3. William Kimberley," Bosch Automotive Handbook", 6th Edition, Robert Bosch GmbH, 2004.
4. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN No: 978-3-658-01783-5.

REFERENCE BOOKS:

1. James D Halderman, " Automotive Electrical and Electronics" , Prentice Hall, USA, 2013
2. Tom Denton, "Automotive Electrical and Electronics Systems," Third Edition, 2004, SAE International.
3. Patranabis.D, " Sensors and Transducers", 2nd Edition, Prentice Hall India Ltd,2003
4. William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective" 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.

U23EEO22	ELECTRICAL, ELECTRONIC AND MAGNETIC MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Understanding the importance of various materials used in electrical, electronics and magnetic applications
2. Acquiring knowledge on the properties of electrical, electronics and magnetic materials.
3. Gaining knowledge on the selection of suitable materials for the given application
4. Knowing the fundamental concepts in Semiconducting materials
5. Getting equipped with the materials used in optical and optoelectronic applications.

UNIT I DIELECTRIC MATERIALS 9

Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength,breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electricconductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties offerromagnetic materials in static fields, spontaneous, polarization, curie point, anti-ferromagnetic materials, piezoelectric materials, pyroelectric materials.

UNIT II MAGNETIC MATERIALS 9

Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials,magnetic Anisotropy, Magnetostriction, diamagnetism, magnetically soft and hard materials,special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanentMagnets, ageing of magnets. Factors effecting permeability and Hysteresis

UNIT III SEMICONDUCTOR MATERIALS 9

Properties of semiconductors, Silicon wafers, integration techniques, Large and very largescale Integration techniques. Concept of superconductivity; theories and examples for hightemperature superconductivity; discussion on specific superconducting materials; commentson fabrication and engineering applications.

9

UNIT IV MATERIALS FOR ELECTRICAL APPLICATIONS

Materials used for Resistors, rheostats, heaters, transmission line structures, strandedconductors, bimetals fuses, soft and hard solders, electric contact materials, electric carbonmaterials, thermocouple materials. Solid, Liquid and Gaseous insulating materials, Effect ofmoisture on insulation.

UNITV OPTICAL AND OPTOELECTRONIC MATERIALS 9

Principles of photoconductivity - effect of impurities - principles of luminescence-laser principles - He-Ne, injection lasers, LED materials - binary, ternary photo-electronic materials- LCD materials - photo detectors - applications of optoelectronic materials - optical fibres andmaterials - electro optic modulators - Kerr effect - Pockels effect.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Understand various types of dielectric materials, their properties in various conditions.
CO2:	Evaluate magnetic materials and their behavior.
CO3:	Evaluate semiconductor materials and technologies.
CO4:	Select suitable materials for electrical engineering applications.
CO5:	Understand the operation of thermocouple materials
CO6:	Identify right material for optical and optoelectronic applications

TEXT BOOKS:

1. Pradeep Fulay, "Electronic, Magnetic and Optical materials", CRC Press, taylor and Francis, 2 nd illustrated edition, 2017.
2. "R K Rajput", "A course in Electrical Engineering Materials", Laxmi Publications, 2009.

REFERENCE BOOKS:

1. T K Basak, "A course in Electrical Engineering Materials", New Age Science Publications, 2009
2. TTTI Madras, "Electrical Engineering Materials", McGraw Hill Education, 2004.
3. Adrianus J. Dekker, "Electrical Engineering Materials", PHI Publication, 2006.
4. S. P. Seth, P. V. Gupta "A course in Electrical Engineering Materials", Dhanpat Rai & amp; Sons, 2011.
5. C. Kittel, "Introduction to Solid State Physics", 7th Edition, John Wiley & Sons,Singapore, (2006).

U23EEO23	INTRODUCTION TO INDUSTRIAL AUTOMATION SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To educate on design of signal conditioning circuits for various applications.
2. To Introduce signal transmission techniques and their design.
3. Study of components used in data acquisition systems interface techniques
4. To educate on the components used in distributed control systems
5. To introduce the communication buses used in automation industries.

UNIT I INTRODUCTION 9

Automation overview, Requirement of automation systems, Architecture of IndustrialAutomation system, Introduction of PLC and supervisory control and data acquisition(SCADA). Industrial bus systems : Modbus & Profibus

UNIT II AUTOMATION COMPONENTS 9

Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pHmeasurement. Actuators, process control valves, power electronics devices DIAC, TRIAC,power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

UNIT III COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS 9

Role of computers in measurement and control, Elements of computer aided measurementand control, man-machine interface, computer aided process control hardware, processrelated interfaces, Communication and networking, Industrial communication systems, Datatransfer techniques, Computer aided process control software, Computer based dataacquisition system, Internet of things (IoT) for plant automation.

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 9

Programmable controllers, Programmable logic controllers, Analog digital input and outputmodules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communicationand networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.

UNITV DISTRIBUTED CONTROL SYSTEM 9

Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Design a signal conditioning circuits for various application
CO2:	Acquire detail knowledge on data acquisition system interface and DCS system.
CO3:	Understand the basics and Importance of communication buses in applied automation Engineering.
CO4:	Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.
CO5:	Able to develop a PLC logic for a specific application on real world problem.
CO6:	Understand features and advantages of DCS

TEXT BOOKS:

1. S.K.Singh, “Industrial Instrumentation”, Tata Mcgraw Hill, 2nd edition companies,2003.
2. C D Johnson, “Process Control Instrumentation Technology”, Prentice Hall India,8th Edition, 2006.
3. E.A.Parr, Newnes , NewDelhi,“Industrial Control Handbook”,3rd Edition, 2000.

REFERENCE BOOKS:

1. John W. Webb and Ronald A. Reis, “Programmable Logic Controllers: Principlesand Applications”, 5th Edition, Prentice Hall Inc., New Jersey, 2003.
2. Frank D. Petruzella, “Programmable Logic Controllers”, 5th Edition, McGraw- Hill,New York, 2016.
3. Krishna Kant, “Computer - Based Industrial Control”, 2nd Edition, Prentice Hall, NewDelhi, 2011.
4. Gary Dunning, Thomson Delmar,“Programmable Logic Controller”, CeneageLearning, 3rd Edition,2005.

U23RAV28	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To educate about the health hazards and the safety measures to be followed in theindustrial environment.
2. Describe industrial legislations (Factories Acts, Workmen's Compensation and other laws)
3. Enacted for the protection of employees health at work settings
4. Describe methods of prevention and control of Occupational Health diseases,
5. To educate about the Accidents / emergencies and other hazards

UNIT I INTRODUCTION 9

Need for developing Environment, Health and Safety systems in work places - Accident CaseStudies - Status and relationship of Acts - Regulations and Codes of Practice - Role of tradeunion safety representatives. International initiatives - Ergonomics and work place.

UNIT II OCCUPATIONAL HEALTH AND HYGIENE 9

Definition of the term occupational health and hygiene - Categories of health hazards -Exposure pathways and human responses to hazardous and toxic substances - Advantages andlimitations of environmental monitoring and occupational exposure limits - Hierarchy ofcontrol measures for occupational health risks - Role of personal protective equipment and theselection criteria - Effects on humans - control methods and reduction strategies for noise,radiation and excessive stress.

UNIT III WORKPLACE SAFETY AND SAFETY SYSTEMS 9

Features of Satisfactory and Safe design of work premises – good housekeeping - lighting andcolour, Ventilation and Heat Control – Electrical Safety – Fire Safety – Safe Systems of workformanual handling operations – Machine guarding – Working at different levels – Processand System Safety.

UNIT IV HAZARDS AND RISK MANAGEMENT 9

Safety appraisal - analysis and control techniques – plant safety inspection – Hazard andRisk Management Techniques Accident investigation Analysis and Reporting –major accident hazard control – Onsite and Offsite emergency Plans.

UNITV ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT 9

Concept of Environmental Health and Safety Management – Elements of EnvironmentalHealth and Safety Management Policy and methods of its effective implementation and review– Elements of Management Principles – Education and Training – Employee Participation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1:	Describe, with example, the common work-related diseases and accidents in occupational setting
CO2:	Name essential members of the Occupational Health team
CO3:	What roles can a community health practitioners play in an Occupational setting
CO4:	Describe Safe Systems of work for manual handling operations
CO5:	To ensure the protection, promotion and maintenance of the health of the employee
CO6:	Understand the Concept of Environmental Health and Safety Management

TEXT BOOKS:

1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education

REFERENCE BOOKS:

1. Frank Lees (2012) 'Lees' Loss Prevention in Process Industries. Butterworth- Heinemann publications, UK, 4th Edition.
2. John Ridley & John Channing (2008)Safety at Work: Routledge, 7th Edition.
3. Dan Petersen (2003) Techniques of Safety Management: A System Approach.
4. Alan Waring.(1996).Safety management system: Chapman &Hall, England Society of Safety Engineers, USA

U23EEO25	ELECTRIC POWER GENERATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Tointroduce various sources of electric power generation
2. Describe the layout of the electric power generating process with labelled block diagram of the specified thermal power plant
3. Explain with sketches working of the given type of nuclear power plant
4. Describe the specified safe practice to the followed with respect to specified thermal power plant an economic aspects
5. Describe the features of substation and grounding systems for safety aspects

UNIT I SOURCES OF ELECTRICAL POWER 9

Wind, solar, fuel cell, tidal, geo-thermal, hydro-electric, thermal-steam, diesel, gas, nuclearpower plants (block diagram approach only). Concept of co-generation. Combined heat andpower distributed generation. Diesel electric plants. Gas turbine plants. Mini, micro, and biogeneration. Concept of distributed generation.

UNIT II HYDRO POWER GENERATION AND THERMAL POWER GENERATION 9

Hydro Power Generation: Selection of site. Classification of hydro-electric plants. Generalarrangement and operation. Hydroelectric plant power station structure and control. Thermal PowerGeneration: Introduction. Main parts of a thermal power plant. Working. Plant layout.

UNIT III NUCLEAR POWER STATION 9

Introduction. Pros and cons of nuclear power generation. Selection of site, cost, components ofreactors. Description of fuel sources. Safety of nuclear power reactor.

UNIT IV ECONOMIC ASPECTS 9

Economics Aspects: Introduction. Terms commonly used in system operation. Diversity factor, load factor, plant capacity factor, plant use factor, plant utilization factor and loss factor, load duration curve. Cost of generating station, factors influencing the rate of tariff designing, tariff, types of tariff.Power factor improvement.

UNITV SUBSTATIONS AND GROUNDING SYSTEMS 9

Substations: Introduction, types, Bus bar arrangement schemes, Location of substation equipment.Reactors and capacitors. Interconnection of power stations. Introduction, grounding systems.Neutral grounding. Ungrounded system. Resonant grounding. Solid grounding, reactancegrounding, resistance grounding. Earthing transformer. Neutral grounding transformer.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Maintain the optimised working of the thermal power plant.
CO2: Maintain the optimised working of large and micro hydro power plants.
CO3: Maintain the optimised working of solar and biomass-based power plants.
CO4: Maintain the optimised working of wind power plants.
CO5: Select the adequate mix of power generation based on economic operation.
CO6: Basic layout of substation and Grounding systems.

TEXT BOOKS:

1. Power System Engineering, A. Chakrabarti, M. L. Soni, and P.V. Gupta, Dhanpat Raiand Co.,NewDelhi.
2. Electric Power Generation, Transmission and Distribution, S. N. Singh, PHI, 2nd Edition,2009.

REFERENCE BOOKS:

1. Elements of Electrical Power System Design, M. V. Deshpande, PHI,2010