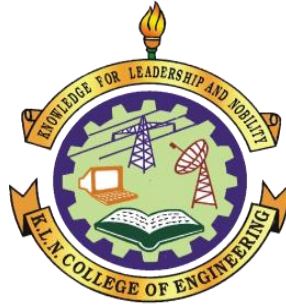


K.L.N. COLLEGE OF ENGINEERING

Pottapalayam-630612, Sivagangai District

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



Estd: 1994

CURRICULUM AND SYLLABUS

I TO VIII Semesters

REGULATIONS 2020

For Under Graduate Program

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM

(For the students admitted in the academic year 2021-2022)



K.L.N. COLLEGE OF ENGINEERING, POTTAPALAYAM
(An Autonomous Institution, Affiliated to Anna University, Chennai)



VISION OF THE INSTITUTION

To become a Centre of Excellence in Technical Education and Research in producing Competent and Ethical professionals to the society.

MISSION OF THE INSTITUTION

To impart Value and Need based curriculum to the students with enriched skill development in the field of Engineering, Technology, Management and Entrepreneurship and to nurture their character with social concern and to pursue their career in the areas of Research and Industry.

VISION OF THE DEPARTMENT

To become a high standard of excellence in Education, Training and Research in the field of Electrical & Electronics Engineering and allied applications.

MISSION OF THE DEPARTMENT

1. To create graduates possess excellent knowledge in Electrical and Electronics Engineering fundamentals.
2. To provide employable graduates for industry and to do high quality research.
3. To Emphasis on Ethics, professional conduct for societal development



K.L.N. COLLEGE OF ENGINEERING, POTTAPALAYAM
(An Autonomous Institution, Affiliated to Anna University, Chennai)



PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

- PEO 1** To excel in industrial or graduate work in Electrical and Electronics Engineering and allied fields.
- PEO 2** To practice their Professions conforming to Ethical Values and Environmentally friendly policies.
- PEO 3** To work in international and multi-disciplinary Environments.
- PEO 4** To successfully adapt to evolving Technologies and stay current with their Professions.

PROGRAM SPECIFIC OUTCOMES (PSOs)

- PSO 1** Apply the fundamentals of Mathematics, Science and Engineering knowledge to identify, formulate, design and investigate complex engineering problems of Electric Circuits, Analog and Digital Electronic Circuits, Electrical Machines and Power Systems.
- PSO 2** Apply appropriate techniques and modern Engineering hardware and software tools in Power Systems to engage in life- long learning and to successfully adapt in multidisciplinary environments.



K.L.N. COLLEGE OF ENGINEERING, POTTAPALAYAM
 (An Autonomous Institution, Affiliated to Anna University, Chennai)



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.



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REGULATIONS 2020

For Under Graduate Program

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM

CATEGORY OF COURSES

- i. **Humanities and Social Sciences / Management Elective (HS) Courses** include Technical English, Environmental Science and Engineering, Engineering Ethics, human values, Communication Skills, Total Quality Management etc.
- ii. **Basic Sciences (BS) Courses** include Mathematics, Physics, and Chemistry.
- iii. **Engineering Sciences (ES) Courses** include Engineering Practices, Engineering Graphics, Basics of Electrical / Electronics / Mechanical / Computer Engineering / Instrumentation etc.
- iv. **Professional Core (PC) Courses** include the core courses relevant to the chosen programme of study.
- v. **Professional Elective (PE) Courses** include the elective courses relevant to the chosen programme of study.
- vi. **Open Elective (OE) Courses** include courses from other departments which a student can choose from the list specified in the curriculum of the students B.E. / B.Tech. Programmes.
- vii. **Employability Enhancement Courses (EEC)** include Project Work and/or Internship, Seminar, Professional Practices, Case Study and Industrial/Practical Training.
- viii. **Mandatory (MC) Courses** include Personality and Character development and the courses recommended by the regulatory bodies such as AICTE, UGC, etc



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REGULATIONS 2020
CHOICE BASED CREDIT SYSTEM
B.E. ELECTRICAL AND ELECTRONICS ENGINEERING
I TO VIII SEMESTERS
CURRICULUM AND SYLLABUS

SEMESTER I

(Common to all B.E. / B.Tech Programmes)

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20HS101	English for Technical Communication	HS	3	3	0	0	3
2.	20BS101	Fundamentals of Engineering Mathematics	BS	4	3	1	0	4
3.	20BS102	Engineering Physics	BS	3	3	0	0	3
4.	20BS103	Engineering Chemistry	BS	3	3	0	0	3
5.	20GE101	Problem Solving using Python Programming	ES	3	3	0	0	3
PRACTICAL								
6.	20BS1L1	Basic Science Laboratory	BS	3	0	0	3	1.5
7.	20GE1L1	Python Programming Laboratory	ES	4	0	0	4	2
8.	20GE1L2	Industrial Practices Workshop	ES	3	0	0	3	1.5
Total Credits								21

SEMESTER II

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20HS201	Advanced Technical Communication (Common to all B.E. / B.Tech programmes)	HS	3	3	0	0	3
2.	20BS201	Laplace Transform and Advanced Calculus (Common to all B.E. / B.Tech programmes)	BS	4	3	1	0	4
3.	20BS203	Physics for Electronics Engineering (Common to B.E. EEE & B.E. ECE programmes)	BS	3	3	0	0	3
4.	20CS201	Programming in C (Common to B.E. EEE, B.E. CSE, B.Tech IT & B.Tech AIDS programmes)	ES	3	3	0	0	3
5.	20EE201	Electric Circuit Analysis	PC	4	3	1	0	4
6.	20GE201	Engineering Graphics (Common to all B.E. / B.Tech programmes)	ES	4	2	0	2	3
PRACTICAL								
7.	20CS2L1	C Programming Laboratory (Common to B.E. EEE, B.E. CSE, B.Tech IT & B.Tech AIDS programmes)	ES	4	0	0	4	2
8.	20EE2L2	Electric Circuits Laboratory	PC	4	0	0	4	2
Total Credits								24

SEMESTER III

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20BS301	Transforms and Partial Differential Equations (Common to B.E. Mech & B.E. EEE programmes)	BS	4	3	1	0	4
2.	20EE301	Digital Logic Circuits	PC	3	3	0	0	3
3.	20EE302	Electron Devices and Circuits	PC	3	3	0	0	3
4.	20EE303	Electromagnetic Theory	PC	4	3	1	0	4
5.	20EE304	Electrical Machines - I	PC	4	3	1	0	4
6.	20HS301	Universal Human Values (Common to all B.E. / B.Tech programmes)	HS	3	2	1	0	3
PRACTICAL								
7.	20EE3L1	Electronics Laboratory	PC	3	0	0	3	1.5
8.	20EE3L2	Electrical Machines Laboratory - I	PC	3	0	0	3	1.5
Total Credits								24

SEMESTER IV

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20BS402	Numerical Methods	BS	4	3	1	0	4
2.	20EE401	Electrical Machines - II	PC	4	3	1	0	4
3.	20EE402	Transmission and Distribution	PC	3	3	0	0	3
4.	20EE403	Linear Integrated Circuits and Applications	PC	3	3	0	0	3
5.	20EE404	Measurements and Instrumentation	PC	3	3	0	0	3
6.	20HS401	Environmental Science and Engineering (Common to all B.E. / B.Tech programmes)	HS	2	2	0	0	2
PRACTICAL								
7.	20EE4L1	Electrical Machines Laboratory - II	PC	3	0	0	3	1.5
8.	20EE4L2	Linear and Digital Integrated Circuits Laboratory	PC	3	0	0	3	1.5
9.	20EE4L3	Technical Seminar	EEC	2	0	0	2	1
Total Credits								23

SEMESTER V

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20EE501	Power System Analysis	PC	4	3	1	0	4
2.	20EE502	Power Electronics	PC	3	3	0	0	3
3.	20EE503	Digital Signal Processing	PC	4	3	1	0	4
4.	20EE504	Control Systems	PC	4	3	1	0	4
5.	20EE505	Microprocessors, Microcontrollers and Applications	PC	3	3	0	0	3
6.		Professional Elective - I	PE	-	-	-	-	3
7.	20MC501	Constitution of India (Common to all B.E. / B.Tech programmes)	MC	1	1	0	0	-
PRACTICAL								
8.	20EE5L1	Control and Instrumentation Laboratory	PC	3	0	0	3	1.5
9.	20EE5L2	Microprocessors and Microcontrollers Laboratory	PC	3	0	0	3	1.5
10.	20HS4L2	Professional Communication Laboratory (Common to B.E. EEE, B.E. CSE, B.Tech IT & B.Tech AIDS programmes)	EEC	2	0	0	2	1
Total Credits								25

SEMESTER VI

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20EE602	Power System Operation and Control	PC	3	3	0	0	3
2.	20IT301	Object Oriented Programming (Common to B.E. EEE & B.Tech IT programmes)	ES	3	3	0	0	3
3.		Open Elective - I	OE	3	3	0	0	3
4.		Professional Elective - II	PE	-	-	-	-	3
5.		Professional Elective - III	PE	-	-	-	-	3
6.		Professional Elective - IV	PE	-	-	-	-	3
PRACTICAL								
7.	20EE6L1	Power Electronics and Drives Laboratory	PC	3	0	0	3	1.5
8.	20EE6L2	Mini Project - I	EEC	4	0	0	4	2
9.	20CS6L3	Object Oriented and JAVA Programming Laboratory	ES	3	0	0	3	1.5
Total Credits								23

SEMESTER VII

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20EE701	Protection and Switchgear	PC	3	3	0	0	3
2.	20EE702	Renewable Energy Systems	PC	3	3	0	0	3
3.		Open Elective - II	OE	3	3	0	0	3
4.		Professional Elective - V	PE	-	-	-	-	3
5.		Professional Elective - VI	PE	-	-	-	-	3
6.		Management Elective	HS	3	3	0	0	3
PRACTICAL								
7.	20EE7L1	Power System Simulation Laboratory	PC	3	0	0	3	1.5
8.	20EE7L2	Renewable Energy Systems Laboratory	PC	3	0	0	3	1.5
9.	20EE7L3	Mini Project - II	EEC	6	0	0	6	3
Total Credits								24

SEMESTER VIII

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICAL								
1	20EE8L1	Project Work	EEC	20	0	0	20	10
Total Credits								10

TOTAL NO. OF CREDITS: 174

PROFESSIONAL ELECTIVE (PE) : VERTICALS

Vertical I	Vertical II	Vertical III	Vertical IV	Vertical V	Vertical VI
Modern Power System Engineering	Power Electronics Converters and Drives	Electric Vehicle Technology	Embedded Systems and Controllers	Advanced Control Systems Engineering	Diversified Courses
Power Quality	Modern Power Converters	Power Electronic Converters for Electric Vehicles	Embedded Processors	Modern Control System	Operations Research
Smart Grid	Special Electrical Machines	Electric Vehicles and Power Management	Embedded C-Programming	System Identification and Adaptive Control	Computer Organization and Architecture
Flexible AC Transmission System	Solid State Drives	Electric Vehicle Design, Mechanics and Control	Embedded System Design	Optimal Control	Block Chain Technology
Energy Auditing and Management	Control of Electrical Drives	Design of Electric Vehicle Charging System	Embedded Control for Electric Drives	Process Modeling and Simulation	Data Structures and Algorithms
High Voltage Engineering	SMPS and UPS	Testing of Electric Vehicles	Smart System Automation	Computer Control of Processes	Soft Computing
Electric Energy Generation, Utilization and Conservation	Power Electronics for Renewable Energy Systems	Grid Integration of Electric Vehicles	Embedded System for Automotive Applications	Principles of Robotics	Biomedical Instrumentation
Under Ground Cable Engineering	Multilevel Power Converters	Intelligent Control of Electric Vehicles	VLSI Design	Machine Monitoring System	Energy Storage Systems
Substation Engineering and Automation	Control of Power Electronics Circuits	Design of Electrical Apparatus	MEMS and NEMS	Model Based Control	Probability and Statistics

VERTICAL I : Modern Power System Engineering

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20EEV11	Power Quality	PE	3	3	0	0	3
2.	20EEV21	Smart Grid	PE	3	3	0	0	3
3.	20EEV31	Flexible AC Transmission System	PE	3	3	0	0	3
4.	20EEV41	Energy Auditing and Management	PE	3	3	0	0	3
5.	20EEV51	High Voltage Engineering	PE	3	3	0	0	3
6.	20EEV61	Electric Energy Generation, Utilization and Conservation	PE	3	3	0	0	3
7.	20EEV71	Under Ground Cable Engineering	PE	3	3	0	0	3
8.	20EEV81	Substation Engineering and Automation	PE	3	3	0	0	3

VERTICAL II : Power Electronics Converters and Drives

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20EEV12	Modern Power Converters	PE	3	3	0	0	3
2.	20EEV22	Special Electrical Machines	PE	3	3	0	0	3
3.	20EEV32	Solid State Drives	PE	3	3	0	0	3
4.	20EEV42	Control of Electrical Drives	PE	3	3	0	0	3
5.	20EEV52	SMPS and UPS	PE	3	3	0	0	3
6.	20EEV62	Power Electronics for Renewable Energy Systems	PE	3	3	0	0	3
7.	20EEV72	Multilevel Power Converters	PE	3	3	0	0	3
8.	20EEV82	Control of Power Electronics Circuits	PE	3	3	0	0	3

VERTICAL III : Electric Vehicle Technology

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20EEV13	Power Electronic Converters for Electric Vehicles	PE	3	3	0	0	3
2.	20EEV23	Electric Vehicles and Power Management	PE	3	3	0	0	3
3.	20EEV33	Electric Vehicle Design, Mechanics and Control	PE	4	2	0	2	3
4.	20EEV43	Design of Electric Vehicle Charging System	PE	3	3	0	0	3
5.	20EEV53	Testing of Electric Vehicles	PE	3	3	0	0	3
6.	20EEV63	Grid Integration of Electric Vehicles	PE	3	3	0	0	3
7.	20EEV73	Intelligent Control of Electric Vehicles	PE	4	2	0	2	3
8.	20EEV83	Design of Electrical Apparatus	PE	3	3	0	0	3

VERTICAL IV : Embedded Systems and Controllers

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20EEV14	Embedded Processors	PE	3	3	0	0	3
2.	20EEV24	Embedded C-Programming	PE	3	3	0	0	3
3.	20EEV34	Embedded System Design	PE	3	3	0	0	3
4.	20EEV44	Embedded Control for Electric Drives	PE	3	3	0	0	3
5.	20EEV54	Smart System Automation	PE	4	2	0	2	3
6.	20EEV64	Embedded System for Automotive Applications	PE	4	2	0	2	3
7.	20EEV74	VLSI Design	PE	3	3	0	0	3
8.	20EEV84	MEMS andNEMS	PE	4	2	0	2	3

VERTICAL V : Advanced Control Systems Engineering

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20EEV15	Modern Control System	PE	3	3	0	0	3
2.	20EEV25	System Identification and Adaptive Control	PE	3	3	0	0	3
3.	20EEV35	Optimal Control	PE	3	3	0	0	3
4.	20EEV45	Process Modeling and Simulation	PE	3	3	0	0	3
5.	20EEV55	Computer Control of Processes	PE	3	3	0	0	3
6.	20EEV65	Principles of Robotics	PE	3	3	0	0	3
7.	20EEV75	Machine Monitoring System	PE	3	3	0	0	3
8.	20EEV85	Model Based Control	PE	3	3	0	0	3

VERTICAL VI: Diversified Courses

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20EEV16	Operations Research	PE	3	3	0	0	3
2.	20EEV26	Computer Organization and Architecture	PE	3	3	0	0	3
3.	20EEV36	Block Chain Technology	PE	3	3	0	0	3
4.	20EEV46	Data Structures and Algorithms	PE	3	3	0	0	3
5.	20EEV56	Soft Computing	PE	3	3	0	0	3
6.	20EEV66	Biomedical Instrumentation	PE	3	3	0	0	3
7.	20EEV76	Energy Storage Systems	PE	3	3	0	0	3
8.	20EEV86	Probability and Statistics	PE	3	3	0	0	3

OPEN ELECTIVE - I (OE - I)

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20OE101	Mechatronics and Applications	OE	3	3	0	0	3
2.	20OE303	Fundamentals of Wireless Communication	OE	3	3	0	0	3
3.	20OE304	Satellite Communication Systems	OE	3	3	0	0	3
4.	20OE401	Fundamentals of Artificial Intelligence	OE	3	3	0	0	3
5.	20OE402	Introduction to Database Management Systems	OE	3	3	0	0	3
6.	20OE403	Computer Communication Networks	OE	3	3	0	0	3
7.	20OE404	Cloud Infrastructure and Technologies	OE	3	3	0	0	3
8.	20OE503	Internet of Things and Applications	OE	3	3	0	0	3
9.	20OE602	Supply Chain Management	OE	3	3	0	0	3
10.	20OE702	Fundamentals of MEMS	OE	3	3	0	0	3

OPEN ELECTIVE - II (OE - II)

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20OE105	Solar Photovoltaic Fundamentals and Applications	OE	3	3	0	0	3
2.	20OE108	Industrial Safety Practices	OE	3	3	0	0	3
3.	20OE306	Consumer Electronics	OE	3	3	0	0	3
4.	20OE405	Machine Learning Techniques	OE	3	3	0	0	3
5.	20OE407	Computer Graphics	OE	3	3	0	0	3
6.	20OE408	Essentials of Data Analytics	OE	3	3	0	0	3
7.	20OE505	Information Security Essentials	OE	3	3	0	0	3
8.	20OE507	Concepts of Ethical Hacking	OE	3	3	0	0	3
9.	20OE607	New Generation Hybrid Vehicles	OE	3	3	0	0	3
10.	20OE705	Logic and Distributed ControlSystem	OE	3	3	0	0	3

MANAGEMENT ELECTIVE

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20HS5A1	Management Concepts and Organizational Behaviour	HS	3	3	0	0	3
2.	20HS5A2	Industrial Marketing	HS	3	3	0	0	3
3.	20HS6A1	Intellectual Property Rights	HS	3	3	0	0	3
4.	20HS6B1	Project Management and Entrepreneurship	HS	3	3	0	0	3
5.	20HS7A2	Total Quality Management	HS	3	3	0	0	3
6.	20HS8A1	Human Relations at Work	HS	3	3	0	0	3
7.	20HS8B2	Economics for Engineers	HS	3	3	0	0	3

OPEN ELECTIVE - I (VI SEMESTER) - offered to other Departments

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20OE201	Fundamentals of Renewable Energy System	OE	3	3	0	0	3
2.	20OE202	Principles of Measurements and Instrumentation	OE	3	3	0	0	3
3.	20OE203	Introduction to Nanoscience	OE	3	3	0	0	3
4.	20OE204	Automotive Electrical Machines	OE	3	3	0	0	3

OPEN ELECTIVE - II (VII SEMESTER) - offered to other Departments

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20OE205	Industrial Energy Auditing and Management	OE	3	3	0	0	3
2.	20OE206	Fundamentals of Fibre Optics and Lasers	OE	3	3	0	0	3
3.	20OE207	Electric Power Quality	OE	3	3	0	0	3
4.	20OE208	Electrical Drives and Control for Automation	OE	3	3	0	0	3

HUMANITIES AND SOCIAL SCIENCES (HS)

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20HS101	English for Technical Communication	HS	3	3	0	0	3
2.	20HS201	Advanced Technical Communication	HS	3	3	0	0	3
3.	20HS301	Universal Human Values	HS	3	2	1	0	3
4.	20HS401	Environmental Science and Engineering	HS	2	2	0	0	2
Total Credits (HS)								11

BASIC SCIENCES (BS)

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20BS101	Fundamentals of Engineering Mathematics	BS	4	3	1	0	4
2.	20BS102	Engineering Physics	BS	3	3	0	0	3
3.	20BS103	Engineering Chemistry	BS	3	3	0	0	3
4.	20BS1L1	Basic Science Laboratory	BS	3	0	0	3	1.5
5.	20BS201	Laplace Transform and Advanced Calculus	BS	4	3	1	0	4
6.	20BS203	Physics for Electronics Engineering	BS	3	3	0	0	3
7.	20BS301	Transforms and Partial Differential Equations	BS	4	3	1	0	4
8.	20BS402	Numerical Methods	BS	4	3	1	0	4
Total Credits (BS)								26.5

PROFESSIONAL CORE (PC)

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20EE201	Electric Circuit Analysis	PC	4	3	1	0	4
2.	20EE2L2	Electric Circuits Laboratory	PC	4	0	0	4	2
3.	20EE301	Digital Logic Circuits	PC	3	3	0	0	3
4.	20EE302	Electron Devices and Circuits	PC	3	3	0	0	3
5.	20EE303	Electromagnetic Theory	PC	4	3	1	0	4
6.	20EE304	Electrical Machines - I	PC	4	3	1	0	4
7.	20EE3L1	Electronics Laboratory	PC	3	0	0	3	1.5
8.	20EE3L2	Electrical Machines Laboratory - I	PC	3	0	0	3	1.5
9.	20EE401	Electrical Machines - II	PC	4	3	1	0	4
10.	20EE402	Transmission and Distribution	PC	3	3	0	0	3
11.	20EE403	Linear Integrated Circuits and Applications	PC	3	3	0	0	3
12.	20EE404	Measurements and Instrumentation	PC	3	3	0	0	3
13.	20EE4L1	Electrical Machines Laboratory - II	PC	3	0	0	3	1.5
14.	20EE4L2	Linear and Digital Integrated Circuits Laboratory	PC	3	0	0	3	1.5
15.	20EE501	Power System Analysis	PC	4	3	1	0	4
16.	20EE502	Power Electronics	PC	3	3	0	0	3
17.	20EE503	Digital Signal Processing	PC	4	3	1	0	4
18.	20EE504	Control Systems	PC	4	3	1	0	4
19.	20EE505	Microprocessors, Microcontrollers and Applications	PC	3	3	0	0	3
20.	20EE5L1	Control and Instrumentation Laboratory	PC	3	0	0	3	1.5
21.	20EE5L2	Microprocessors and Microcontrollers Laboratory	PC	3	0	0	3	1.5
22.	20EE602	Power System Operation and Control	PC	3	3	0	0	3
23.	20EE6L1	Power Electronics and Drives Laboratory	PC	3	0	0	3	1.5
24.	20EE701	Protection and Switchgear	PC	3	3	0	0	3
25.	20EE702	Renewable Energy Systems	PC	3	3	0	0	3
26.	20EE7L1	Power System Simulation Laboratory	PC	3	0	0	3	1.5
27.	20EE7L2	Renewable Energy Systems Laboratory	PC	3	0	0	3	1.5
Total Credits (PC)								73.5

ENGINEERING SCIENCES (ES)

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20GE101	Problem Solving using Python Programming	ES	3	3	0	0	3
2.	20GE1L1	Python Programming Laboratory	ES	4	0	0	4	2
3.	20GE1L2	Industrial Practices Workshop	ES	3	0	0	3	1.5
4.	20CS201	Programming in C	ES	3	3	0	0	3
5.	20GE201	Engineering Graphics	ES	4	2	0	2	3
6.	20CS2L1	C Programming Laboratory	ES	4	0	0	4	2
7.	20IT301	Object Oriented Programming	ES	3	3	0	0	3
8.	20CS6L3	Object Oriented and JAVA Programming Laboratory	ES	3	0	0	3	1.5
Total Credits (ES)								19

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20EE4L3	Technical Seminar	EEC	2	0	0	2	1
2.	20HS4L2	Professional Communication Laboratory	EEC	2	0	0	2	1
3.	20EE6L2	Mini Project - I	EEC	4	0	0	4	2
4.	20EE7L3	Mini Project - II	EEC	6	0	0	6	3
5.	20EE8L1	Project Work	EEC	20	0	0	20	10
Total Credits (EEC)								17

MANDATORY COURSES (MC)

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	20MC501	Constitution of India	MC	1	1	0	0	-

SUMMARY

S.No.	CATEGORY	NUMBER OF CREDITS									
		I SEM	II SEM	III SEM	IV SEM	V SEM	VI SEM	VII SEM	VIII SEM	Total Credits	Credit %
1.	Humanities and Social Sciences / Management Elective (HS)	3	3	3	2			3		14	8.05
2.	Basic Sciences (BS)	11.5	7	4	4					26.5	15.23
3.	Engineering Sciences (ES)	6.5	8				4.5			19	10.92
4.	Employability Enhancement Courses (EEC)				1	1	2	3	10	17	9.77
5.	Professional Core (PC)		6	17	16	21	4.5	9		73.5	42.24
6.	Professional Electives (PE)					3	9	6		18	10.34
7.	Open Elective (OE)						3	3		6	3.45
8.	Mandatory Courses (MC)					-				-	
Credits per Semester		21	24	24	23	25	23	24	10	174	
Credits per Year		45		47		48		34		174	
Total Credits		174									

20HS101	ENGLISH FOR TECHNICAL COMMUNICATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course is designed for entry level Engineering and Technology curriculum enabling the students to learn, acquire and apply for their learning and career.
- The course is aimed at providing effective skills for promoting communication skills through English.
- Students will benefit in conversing with the peers, faculty and fellow professionals.
- The outcome of this course contains refined level of English proficiency by acquiring all four skills, listening, speaking, reading and writing to prepare them for global readiness.

PRE-REQUISITE: NIL

UNIT - I FOCUSING LANGUAGE DEVELOPMENT 9

Listening: Listening to TV News, Guest Lecturers, Note – taking. **Speaking:** Pronunciation Common Vocabulary – Technical Vocabulary – Answering Peer Questions – Conversation with Teacher. **Reading:** News magazines, Reading for unfamiliar words, Variety of News Items **Writing:** Word formation – Auxiliary verbs – Modal Verbs – Sentence Types – Affirmative, Negative, Interrogative, Concord – Dialogue Writing, Letter to Principal / Director – Instructions using Auxiliary

UNIT - II GRAMMAR AND TECHNICAL READING 9

Listening: Listening to Peer Conversations – Brief Speeches – Listening for Specific Information – Recap of Speeches. **Speaking:** Wh Questions, Day today conversations, Telephonic enquiries official/formal enquiries. **Reading:** Technical Essays – Identifying Sentence Types – Classifying the verb patterns. **Writing:** Tenses – Simple Present, Present Progressive, Present Perfect, Present Perfect Continuous – Voice – Active & Passive – Précis Writing – Essay Writing

UNIT - III GRAMMAR AND LANGUAGE DEVELOPMENT 9

Listening: TV interviews, Commentaries, Digital Videos for World Information. **Speaking:** Telephonic Conversation – Classroom Activities – Conversing Information. **Reading:** Coherence, Development of Thoughts. **Writing:** Tenses – Simple Past, Past Progressive, Past Perfect, Past perfect continuous – Impersonal Passive-Narrating the past events, Letter to friend/father about Industrial Visit/Functions held – Narrating the past experience using Impersonal Passive voice

UNIT - IV READING AND LANGUAGE DEVELOPMENT 9

Listening: Listening to Dialects of English – British & American Regional. **Speaking:** Role Plays, Extempore, Responding to specific questions. **Reading:** Comprehensive passages, Reading for specific points. **Writing:** Tenses – Simple Future, Future progressive, Future Perfect, Future Perfect continuous – Definition – Phrases of Reason – Cause & Effect, Recommendations, Argumentative Essays, Letter to the Editor on Social Issues – Analytical Essays on Social hazards using Cause and Effect.

UNIT - V EXTENDED WRITING 9

Listening: Listening to Technical Seminar speeches – Listening to achievers, eminent personalities – Dialects – Australian – African – Asian. **Speaking:** Welcome address, Compeering, Vote of Thanks, Peer debates. **Reading:** Texts on self-confidence, motivation, success path. **Writing:** Contracted forms, Conditionals, Articles, Preposition, Tense – ‘going to’ - Error Spotting, Sequence Words – Rearranging – Writing a Book Review – Summary writing – Rearranging Sentences using Sequence Words, Note Making

TOTAL: 45 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Listen, Comprehend and Correspond with others at various contexts **(AD)**
- Speak legibly and fluently under various life-time situations by applying proper communication modules. **(AD)**
- Read and understand a variety of writings and technical text by analyzing the meaning and language. **(AD)**
- Apply clear and legible writing skills in error free style in coherent manner **(AD)**
- Remember and use various communicative skills in precise and efficient way on technological contexts **(AD)**
- Form situational conversations and technical writing styles for interpersonal and effective communication **(AD)**

TEXT BOOKS:

1. Board of Editors. “Using English A Course book for Undergraduate Engineers and Technologists”. Orient Black Swan Limited, Hyderabad: 2015
2. Richards, C. Jack. “Interchange Students’ Book-2”, New Delhi: CUP, 2015

REFERENCES:

1. Murphy, Raymond “English Grammar in Use with Answers: Reference and Practice for Intermediate Students”, Cambridge: CUP, 2004
2. Thomson, A.J. and Martinet, A.V. “A Practical English Grammar”, OUP, New Delhi: 1986
Anne Laws, “Writing Skills”, Orient Black Swan, Hyderabad, 2011
3. Board of Editor, “English for Technical Communication”, Great Mind Publication, Chennai 2018

20BS101	FUNDAMENTALS OF ENGINEERING MATHEMATICS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To relate various methods of Matrix Algebra to handle practical problems arising in the field of engineering.
- The main aim of this course is to achieve conceptual understanding and to retain the best traditions of Calculus.
- The syllabus is designed to provide the basic tools of Calculus of Single and Multivariable, mainly for the purpose of modeling the engineering problems mathematically and obtaining solutions.

PRE-REQUISITE: NIL**UNIT - I MATRICES 12**

Introduction to Matrices-Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley-Hamilton Theorem – Diagonalization of matrices – Reduction of a Quadratic form to Canonical form by Orthogonal transformation – Nature of Quadratic forms.

UNIT - II DIFFERENTIAL CALCULUS 12

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules - Differentiation of Polynomials, Exponential, Trigonometric, Hyperbolic, Logarithmic and Implicit functions- Maxima and Minima of functions of single variable.

UNIT – III FUNCTIONS OF SEVERAL VARIABLES 12

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

UNIT – IV INTEGRAL CALCULUS 12

Definite and Indefinite integrals - Substitution rule - Techniques of integration - Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions, Improper 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.

TOTAL: 60 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Find the Eigen values and Eigen vectors to diagonalize a matrix, reduce quadratic form to canonical form. (K3)
- Apply the concept of limits, continuity and rules of differentiation to differentiate some standard functions and apply the techniques of differentiation to differentiate various types of functions. (K3)
- Understand the concepts of Concavity and Convexity by finding the Critical points, point of Inflection and to find Maxima and Minima functions of Single variable. (K3)
- Find the derivatives of functions of two variables and apply them to calculate the maxima and minima. (K3)
- Evaluate integrals using techniques of integration, such as substitution, partial fractions and integration by parts. (K3)
- Apply various techniques to solve higher order differential equations with constant and variable coefficients. (K3)

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2017.
2. T. Veerarajan., "Engineering Mathematics I", The Tata Mc Graw Hill Publication-New Delhi, First Edition, 2018

REFERENCES:

1. James Stewart, "Calculus, Early Transcendental", Cengage Learning, 7th Edition, New Delhi, 2015. [For units II & III].
2. Kreyszig Erwin, "Advanced Engineering Mathematics", John Wiley and Sons, 9th Edition, New Delhi, 2006.
3. Wiley, "Calculus- International Student version", 10th Edition, Wiley India Pvt. Ltd, New Delhi 2017.
4. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 5th Edition, 2016.
5. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics II", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.), New Delhi, 9th Edition, 2014.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Demonstrate the properties of elasticity and measure the different moduli of elasticity. (K3)
- Examine the characteristics of laser and optical fiber (K3)
- Apply the concepts of ultrasonics in engineering (K3)
- Explain black body radiation, properties of matter waves and Schrodinger equation (K3)
- Classify the Bravais lattices and different types of crystal structures (K3)
- Gain information on growth of crystals and deformations (K3)

TEXT BOOKS:

1. R. K. Gaur and S. L. Gupta, "Engineering Physics", Dhanpat Rai Publications, 2012.
2. B. K. Pandey and S. Chaturvedi, "Engineering Physics", Cengage Learning India, 2018.
3. V.Rajendran, "Engineering Physics", Tata McGraw Hill Education Private Limited, 2011.

REFERENCES:

1. D.Halliday, R. Resnick and J. Walker, "Principles of Physics", Wiley publisher, 10th Edition, 2015.
2. R.A.Serway and J.W. Jewett, "Physics for Scientists and Engineers", Cengage Learning, 2014.
3. P.A.Tipler and G. Mosca, "Physics for Scientists and Engineers with Modern Physics", W.H.Freeman, 2007.
4. D.K.Bhattacharya and T. Poonam, "Engineering Physics", Oxford University Press, 2017.

20BS103

ENGINEERING CHEMISTRY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To make the students, familiar with boiler feed water requirements, related problems and water treatment techniques.
- To learn the principle of electrochemical cell, types of corrosion and its control.
- To develop an understanding of the basic concepts of phase rule and its applications to one and two component systems and appreciate the purpose and significance of alloys.
- To be familiar with different types of fuel and their characteristics and also functioning of energy storage devices.
- To understand the techniques of spectra and chromatography for analytical purpose.

PRE-REQUISITE: NIL**UNIT - I WATER AND ITS TREATMENT 9**

Characteristics of water; Hard water, Soft water, difference; Hardness – types of hardness, expression of hardness, units, removal of hardness (boiling, soda lime process), estimation of hardness of water by EDTA method (problems); Boiler feed water – requirements – disadvantages of using hard water in boilers (scale and sludge, priming and foaming, caustic embrittlement, boiler corrosion); Treatment of boiler feed water – internal treatment (carbonate, phosphate, and calgon conditioning) external treatment – ion exchange process, zeolite process; Purification of water - reverse osmosis, electro dialysis, Application of nanomaterials in water purification.

UNIT - II ELECTROCHEMISTRY AND CORROSION 9

Electrochemical cell - redox reaction, electrode potential- origin of electrode potential- oxidation potential- reduction potential, - electrochemical series and its significance - Nernst equation (derivation and problems).

Corrosion- causes- factors, electrochemical corrosion (galvanic, differential aeration), corrosion control - material selection and design aspects - electrochemical protection – sacrificial anode method and impressed current cathodic method – corrosion inhibitors. Metallic coating – Electroplating – Factors - Electroplating of Copper and Electroless plating of Nickel.

UNIT - III PHASE RULE AND ALLOYS 9

Phase rule - introduction, definition of terms with examples; One component system - water system; Reduced phase rule - two component system, classification, lead-silver system; Alloys – introduction, definition, properties of alloys, significance of alloying; Functions and effects of alloying elements; Heat treatment of steel - annealing, hardening, tempering, carburizing, nitriding; Ferrous alloys- nichrome and stainless steel (18/8); Non-ferrous alloys – brass and bronze.

UNIT - IV FUELS AND BATTERIES 9

Fuels – classification, characteristics; Petrol – characteristics, knocking, octane number; Diesel – characteristics, cetane number; Natural gas (CNG), LPG, Power alcohol, Biodiesel, Gasohol; Combustion of fuels – calorific value, GCV and NCV (Problems), calculation of theoretical air for combustion (Problems), Ignition temperature, explosive range, flue gas analysis (Orsat apparatus);

Batteries – primary and secondary batteries, lead-acid battery, lithium ion battery, Fuel cell (hydrogen oxygen fuel cell).

UNIT - V ANALYTICAL TECHNIQUES**9**

Spectroscopic techniques – UV-visible (Principle and Instrumentation – Block Diagram only and applications), IR (Principle and Instrumentation – Block Diagram only and applications), ¹H NMR ((Principle and Instrumentation – Block Diagram only) – Chromatography – HPLC - Flame photometry – Estimation of sodium by Flame photometry.

TOTAL: 45 PERIODS**OUTCOMES:****AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:**

- Identify the problems of hardness of water in boilers and to treat water by various methods. (K2)
- Construct electrochemical cell and apply Nernst equation for an electrochemical cell and identify various methods to control corrosion. (K3)
- Analyse the phase diagram of one component and two component system and describe the various methods of heat treatment of steel. (K2)
- Categorise the various types of fuels by their characteristics and analyse the flue gas by Orsat's method. (K2)
- Illustrate the working of lead acid battery, lithium ion battery and fuel cell. (K2)
- Describe the instrumentation and working of UV, IR, ¹HNMR, HPLC, and flame photometry. (K2)

TEXT BOOKS:

1. P.C. Jain and Monika Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2017
2. S.S Dara and S.S Umare, "A Text Book of Engineering Chemistry", S.Chand & Company Limited, 20th Edition, 2018

REFERENCES:

1. Shashi Chawla, "A Textbook of Engineering Chemistry", Dhanpat Rai & CO. (PVT) LTD, New Delhi, 2012.
2. B.R. Puri, L.R. Sharma, M.S. Pathania, Vishal, "Principles of Physical Chemistry", Vishal Publishing Co., Punjab, 47th Edition, 2017.
3. G Palanna, "Engineering Chemistry", McGraw Hill Education (India) PVT, LTD, Chennai, 2017.
4. Dr. Sunita Rattan, "A Textbook of Engineering Chemistry", S.K.Kataria & Sons, New Delhi, 2012

20GE101	PROBLEM SOLVING USING PYTHON PROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know the basics of Computers and algorithmic problem solving
- To understand Python programs with conditional and looping constructs.
- To define Python functions and strings.
- To use Python data structures – lists, tuples, sets and dictionaries.
- To do input/output with files in Python.

PRE-REQUISITE: NIL**UNIT - I COMPUTER FUNDAMENTALS AND PROBLEM SOLVING 9**

Introduction to Computer System – Block Diagram of Computer, Types of Memory, I/O Devices, Application Programs, System Programs – Loader, linker, assembler, compiler, interpreter, Programming process – source code to executable code, Problem Solving Strategies – Problem analysis, Algorithms, Flow Charts, Pseudo Code. Illustrative problems: odd or even number, Leap year, Biggest of three numbers, square root of a number, Sum of n numbers, Armstrong number, Palindrome, Fibonacci Series, Prime number, Bubble Sort and Linear Search.

UNIT - II DATA, EXPRESSIONS, CONTROL FLOW STATEMENTS 9

Python interpreter and interactive mode, values and types – int, float, boolean, string, and list, variables, expressions, statements, tuple assignment, operators and precedence of operators, comments, Control Flow Statements – Conditionals – conditional (if), alternative (if-else), chained conditional (if-elif-else), Iteration – state, while, for, break, continue, pass, Illustrative programs – exchange the values with and without using temporary variables, circulate the values of n variables, distance between two points.

UNIT - III FUNCTIONS, STRINGS 9

Functions – function definition and use, flow of execution, parameters and arguments, function composition, Fruitful functions – return values, parameters, local and global scope, recursion, Strings – string slices, immutability, string functions and methods, string module, Illustrative programs – square root, GCD, exponentiation, Factorial of a number, linear search, binary search.

UNIT - IV LISTS, TUPLES, SETS DICTIONARIES 9

Lists – list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters, Lists as arrays, Tuples – tuple assignment, tuple as return value, Sets - Creating a set, Modifying a set, Removing elements from a set, Set operations- Set Union, Set intersection, Set difference, Set membership test, Iterating through a set, Set methods, Built-in functions with set, Frozenset - Dictionaries – operations and methods, Advanced list processing –List comprehension, Illustrative programs – selection sort, insertion sort, Matrix addition and subtraction, sum an array of numbers.

UNIT - V FILES, MODULES, PACKAGES 9

Files and exception – text files, reading and writing files, format operator, command line arguments, errors and exceptions, handling exceptions, modules, packages – Math and Rand, Illustrative programs – word count, copy file, merge two files.

TOTAL: 45 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain Components of a Computer System, types of programming languages, types of software with examples and purpose. (K3)
- Perform problem analysis, use algorithms and prepare flow charts, pseudo code for solving simple problems. (K3)
- Use Conditional, iteration constructs of python programming and apply to solve simple problems. (K3)
- Use Functions, recursive function, String functions in python programming and apply to perform linear and binary search. (K3)
- Explain the various operations for manipulating Tuples, Dictionaries and Use List to perform simple and sorting operations. (K3)
- Explain file handling operations, exception handling, modules and packages and illustrate programs for word count, file copy, merge operations and exception handling. (K3)

TEXT BOOKS:

1. E. Balagurusamy, "Problem solving and Python Programming", First edition, McGraw Hill Education (India) Private Limited, 2017.
2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016.
(<http://greenteapress.com/wp/think-python/>)

REFERENCES:

1. Yashavant Kanetkar, Aditya Kanetkar, "Let Us Python", 2nd Edition, BPB Publications, 2020.
2. John V Guttag, "Introduction to Computation and Programming Using Python: With Application to Understanding Data", 2nd Edition, PHI Publisher, 2017.
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach", Pearson India Education Services Pvt. Ltd., 2016.
4. Timothy A. Budd, "Exploring Python", Mc-Graw Hill Education (India) Private Ltd., 2015.
5. Paul Gries, Jennifer Campbell and Jason Montojo, "Practical Programming: An Introduction to Computer Science using Python 3.6", 3rd edition, Shroff/O'ReillyPublishers, 2018.
6. Dr. A. Kannan, Dr. L. Sai Ramesh, "Problem Solving and Python Programming, Updated Edition", United Global Publishers Pvt. Ltd., April 2018.

20BS1L1

BASIC SCIENCE LABORATORY

L	T	P	C
0	0	3	1.5

PHYSICS LABORATORY

OBJECTIVES:

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

PRE-REQUISITE: NIL

LIST OF EXPERIMENTS

(Any five to be carried out & one demonstration experiment)

- Determination of Rigidity modulus – Torsional Pendulum.
 - Determination of Young's modulus – Non Uniform Bending.
 - Determination of wavelength and particle size using diode laser.
 - Determination of acceptance angle in an optical fiber.
 - Determination of velocity of sound and compressibility of liquid using ultrasonic interferometer.
 - Determination of band gap of a semiconductor diode.
 - Determination of thickness of a thin wire – Air wedge method.
 - Determination of dispersive power of a prism – Spectrometer*
 - Determination of wavelength of mercury spectrum – Spectrometer grating
- *Demonstration experiment

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- 20HS6A1

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Torsional pendulum set	6
2	Travelling microscope & accessories	6
3	Laser kit	6
4	Ultrasonic interferometer	6
5	Semiconductor band gap kit	6
6	Air wedge set up	6
7	Spectrometer & prism	6
8	Spectrometer & Grating	6

CHEMISTRY LABORATORY**OBJECTIVES:**

- To make the students to acquire practical skill in the determination of water quality parameters through volumetric analysis.
- To have hands on experience in using instruments like pH meter, conductivity meter, potentiometer.
- To acquaint the students with the determination of molecular weight of polymer by viscometer.

PRE-REQUISITE: NIL**Any Five experiments to be given**

- Determination of total, temporary & permanent hardness of water by EDTA method.
- Determination of alkalinity in water sample.
- Determination of dissolved oxygen content of water sample by Winkler's method.
- Determination of strength of given hydrochloric acid using pH meter.
- Estimation of iron content of the given solution using potentiometer.
- Conductometric titration of a strong acid Vs a strong base.
- Determination of strength of acids in a mixture of acids using conductivity meter.
- Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
- Corrosion Experiment – Weight Loss Method.
- Estimation of sodium present in water using flame photometer.

TOTAL(Physics & Chemistry): 45 PERIODS**OUTCOMES:****AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:**

- Estimate the Chemical quality parameter of a water sample.(K3)
- Estimate the strength of acid by conduct metric and pH metric titration. (K3)
- Estimate the amount of iron content in a given solution using potentiometer and the amount of sodium in water using flame photometer. (K3)
- Determine the molecular weight of polyvinyl alcohol using Ostwald viscometer and rate of corrosion by weight loss method. (Demo) (K2)

REFERENCE:

- Vogel's "Text book of quantitative chemical analysis" (8th edition, 2014)

LIST OF APPARATUS AND EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Burette	30
2	Pipette	30
3	Beaker (100ml)	30
4	Conical Flask (250ml)	30
5	Conductivity meter	10
6	Potentiometer	10
7	pH meter	10
8	Viscometer	10
9	Flame Photometer	1
10	Electronic Balance	1

20GE1L1	PYTHON PROGRAMMING LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To write, test, and debug simple Python programs using conditional statements.
- To implement Python programs using loops.
- To use functions for structuring Python programs.
- To implement Python programs using lists.
- To write Python programs for implementing file operations.

PRE-REQUISITE: NIL

LIST OF PROGRAMS

1. Biggest of three numbers, odd or even number, Leap year.
2. GCD, Armstrong Number, Palindrome, Fibonacci Series, Prime number
3. Find the square root and exponentiation of a number with and without built-in functions
4. Linear search and Binary search using Recursion.
5. Find the maximum of a list of numbers
6. Selection sort, Insertion sort
7. First n prime numbers
8. Transpose of a Matrix
9. Multiply matrices
10. Programs that take command line arguments (word count)
11. Find the most frequent words in a text read from a file
12. Merge two files

PLATFORM NEEDED: Python 3 interpreter for Windows/Linux

TOTAL: 60 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Develop simple Python programs using conditional and iterative constructs. (K3)
- Develop simple Python programs using built-in functions and user-defined functions. (K3)
- Develop a Python program using recursion to implement linear and binary search. (K3)
- Develop a Python program using list to implement selection and insertion sort. (K3)
- Develop Python programs to implement matrix operations. (K3)
- Develop a Python program to implement file handling. (K3)

20GE1L2	INDUSTRIAL PRACTICES WORKSHOP	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

- To provide exposure to the students with Hands on Experience on various Basic Industrial Practices in Civil, Mechanical, Electrical and Electronics Engineering.

PRE-REQUISITE: NIL

**GROUP A (CIVIL & MECHANICAL)
LIST OF EXPERIMENTS**

I CIVIL ENGINEERING PRACTICE

UNIT - I CARPENTRY PRACTICE

1. Study of carpentry tools.
2. Preparation of Cross lap joint
3. Preparation of Dovetail joint
4. Preparation of T joint

UNIT - II PLUMBING PRACTICE

1. Study of plumbing tools, pipeline joints, its location and functions: valves, taps, couplings, unions, reducers and elbows in household fittings.
2. Exercise on Preparation of plumbing line sketches for water supply and sewage works.
3. Exercise on providing of basic water line connection for a residential house using plumbing components.
4. Exercise on providing Water line pipe connections for household utilities like water heater, wash basin etc.,

II MECHANICAL ENGINEERING PRACTICE

UNIT - III SHEET METAL PRACTICE

1. Study of sheet metal forming tools.
2. Preparation of a Model of rectangular tray.
3. Preparation of a Model of Conical Funnel.

UNIT - IV MACHINING PRACTICE

1. Study of machining tools.
2. Exercise on Simple turning, Facing, Chamfering
3. Exercise on Taper turning.
4. Exercise on Drilling and Tapping.

UNIT – V METAL JOINING PROCESS

1. Study of welding tools.
2. Exercise to join two metal plates by single butt joint using arc welding.
3. Exercise to join two metal plates by T Fillet joint using arc welding.
4. Exercise to join two metal plates by lap joint using arc welding.

DEMONSTRATION

1. Gas welding process.
2. Refrigeration and Air conditioning process.

**GROUP B (ELECTRICAL & ELECTRONICS)
LIST OF EXPERIMENTS**

I ELECTRICAL ENGINEERING PRACTICE

1. Residential house wiring using switches, fuse, indicator, Fluorescent lamp and Energy Meter.
2. Measurement of Power consumption for CFL, Fluorescent Lamp, LED Lamp and Incandescent lamp.
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.

II ELECTRONICS ENGINEERING PRACTICE

1. Study of Electronic components – Resistor colour coding, Capacitor, Inductor- Measurement using LCR meter, Transistor & Diode – Terminal identification using Multimeter.
2. Study of logic gates AND, OR, EX-OR and NOT.
3. Measurement of AC signal parameter (peak-peak, rms value, period & frequency) using CRO and AFO.
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

TOTAL: 45 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
CIVIL		
S.No	Component Name	No. of Components
1	Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, coupling, unions, elbows, plugs and other fittings	15 sets
2	Carpentry Vice (fitted to work bench)	15 nos
3	Standard wood working tools	15 sets
4	Models of industrial trusses, door joints, furniture joints	5 each
5	Power Tools a. Rotary Hammer b. Demolition Hammer c. Circular Saw d. Planer e. Hand Drilling Machine f. Jigsaw	2 nos 2 nos 2 nos 2 nos 2 nos 2 nos
MECHANICAL		
1	Arc welding transformer with cables and holders	5 nos
2	Welding booth with exhaust facility	5 nos
3	Welding accessories like welding shield, chipping hammer, wire brush, etc.	5 sets

4	Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	2 nos
5	Centre Lathe	2 nos
6	Power Tool: Angle Grinder	2 nos
7	Study purpose items: Refrigerator and Air Conditioner	One each
ELECTRICAL		
1	Assorted electrical components for house wiring	10 sets
2	Electrical measuring instruments	10 sets
3	Study purpose items: Iron box, fan and regulator, emergency lamp	1 each
4	Megger (250V/500V)	1 no.
5	Power Tools a. Range Finder b. Digital Live-wire detector	2 nos 2 nos
ELECTRONICS		
1	Soldering guns	10 nos
2	Assorted electronic components for making circuits	50 nos
3	Small PCBs	10 nos
4	Multimeters	10 nos
5	Regulated of power supply, CRO	1 no. each

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Prepare different carpentry joints and pipe connections with different joints. (K3)
- Make the models using sheet metal. (K3)
- Carry out the basic machining operations. (K3)
- Prepare arc welded joints using welding equipment(K3)
- Demonstrate wiring for a simple residential house; identify the ratings of tube lamp, and calculate the different Electrical quantities. (K3)
- Measure the electronics equipment using LCR meter, Transistor & Diode – Terminal identification using Multimeter. (K3)
- Experimentally analyze AC signal parameters using CRO and AFO and to verify the Truth tables of Logic gates. (K3)
- Experimentally design a Simple circuit using soldering in a PCB, measure ripple factor of Half Wave Rectifier and Full Wave Rectifier. (K3)

20HS201	ADVANCED TECHNICAL COMMUNICATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course is designed for Engineering and Technology curriculum enabling the students to learn, acquire and apply updated elements of English communication.
- The course is aimed at providing effective skills for procuring communication skills for business and advanced technology.
- Students will benefit by learning the four skills – Listening, Speaking, Reading and Writing – to meet the global requirements for their career and higher studies.

PRE-REQUISITE: NIL**UNIT - I TECHNICAL WRITING 9**

Listening: Listening to audio-visuals on personal Interviews, Speeches from Company CEOs, TV Debates. **Speaking:** Wishing, Greeting, Enquiring Hobbies. **Reading:** Editorials, Letter to the Editor Columns, Technical Papers. **Writing:** Analytical writings, Emphasis Techniques, Letter Writing – Business Correspondence, Abstract Writing, Common Errors, Footnotes, Compound words, Preparation of Agenda

UNIT - II BUSINESS ENGLISH AND LANGUAGE DEVELOPMENT 9

Listening: Listening to Audio-Visual documentary, TV Programs of Celebrities Forum. **Speaking:** Self-Expression, Introducing the fellow students, Talking about celebrities, leaders **Reading:** Company Correspondence, Business Correspondence, Technical Text for Vocabulary **Writing:** Bibliography, Sentence Completion, Cloze exercises, Verbal Analogy, Letter – Business enquiry orders, payments, Minutes Preparation.

UNIT - III VISUAL BASED LANGUAGE DEVELOPMENT 9

Listening: Visuals on Group Discussion-Understanding the nuances of GD – Approach – Content – Methodology. **Speaking:** Discussing main points on burning issues, Social issues – Expressing ideas and suggestions. **Reading:** Etiquettes of Non-Verbal Communication. **Writing:** List of common expressions for specified situations – Sentence linkers – Formal Expressions – Suggestions – Reported Speech - Letter to the Editor on Common Issues – Writing the Points in Indirect Form – Check Lists – Numerical Expression

UNIT - IV EMPLOYABILITY CORRESPONDENCE 9

Listening: Listening to Visuals of Technical Paper presentation – Technical and HR interviews **Speaking:** Peer-to-Peer Interview – Mock Interview – Telephone Conversations. **Reading:** Comparative Analyses – Instructions on Public Spots – Time Management concepts – Email Correspondence. **Writing:** Compare and Contrast – Cause and Effect – Purpose and Function – Job Application Letter – Drafting Resume / CV, – Inferring the graphical / Pictorial representations – Bar chart – Pie chart, Instruction – common and technical instructions for a process or a component

UNIT - V TECHNICAL REPORT WRITING 9

Listening: Key note speeches – Annual Reports of institutions / companies. **Speaking:** Answering to the Mock Panel Interview – Sharing of interview experiences – presenting a Technical Paper. **Reading:** Annual Reports – Company Reports – Newspaper reports – Comprehension passages. **Writing:** Homophones – Abbreviations and Acronyms – SI Units – Report Writing with recommendations – Inferring the Graph – Flow Chart – Tables – Technical Papers

TOTAL: 45 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Listen, Understand and create technical correspondence at advanced level (AD)
- Respond or answer to the contextual questions, interview questions, form instructions, draft reports (AD)
- Speak and analyze social issues, come out with effective ideas for discussion, understand the passages for meaning and vocabulary (AD)
- Assess error free technical writings, create legible and coherent technical papers, derive ideas of the given texts in a precise form (AD)
- Remember the updated elements of communication skills, nuances of non-verbal communication, business communication (AD)
- Create technical instructions, process instructions, self-appraisals, Resumes, reports on various situations (AD)

TEXT BOOKS:

1. Board of editors. "Fluency in English A Course book for Engineering and Technology". Orient Blackswan, Hyderabad: 2016
2. Raman, Meenakshi and Sharma, Sangeetha "Technical Communication Principles and Practice". Oxford University Press: New Delhi, 2014.

REFERENCES:

1. Booth-L. Diana, "Project Work", Oxford University Press, Oxford: 2014
2. Grussendorf, Marion, "English for Presentations", Oxford University Press, Oxford: 2007
3. Means, L. Thomas and Elaine Langlois, "English & Communication For Colleges". Cengage Learning, USA: 2007
4. Board of Editor, "Advanced Technical Communication", Great Mind Publication, Chennai : 2019

20BS201	LAPLACE TRANSFORM AND ADVANCED CALCULUS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To make the student familiar with topics such as Multiple Integrals, Vector Calculus, Analytic Functions, Complex Integration and Laplace Transform.
- To learn the concept of basic Vector Calculus which can be widely used for Modeling the various laws of Physics.
- To understand the various methods of Complex Analysis and Laplace Transform can be used for efficiently solving the problems that occur in various branches of Engineering disciplines.

PRE-REQUISITE: NIL

UNIT - I LAPLACE TRANSFORM 12

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.

UNIT - II MULTIPLE INTEGRALS 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 - III VECTOR CALCULUS 12

Gradient and Directional Derivative – Divergence and Curl - Vector Identities – Irrotational and Solenoidal Vector fields – Line Integral over a Plane curve – Surface Integral - Area of a Curved Surface - Volume Integral – Green’s, Gauss divergence and Stoke’s theorems – Verification and Application in evaluating Line, Surface and Volume Integrals.

UNIT - IV ANALYTIC FUNCTIONS 12

Analytic functions – Necessary and Sufficient Conditions for Analyticity in Cartesian and Polar Coordinates – Properties – Harmonic Conjugates – Construction of Analytic Function – Conformal Mapping – Mapping by Functions $w = z+c$, cz , $1/z$, z^2 -Bilinear transformation.

UNIT - V COMPLEX INTEGRATION 12

Line integral – Cauchy’s Integral Theorem – Cauchy’s Integral Formula – Taylor’s and Laurent’s Series – Singularities – Residues – Residue Theorem – Application of Residue Theorem for Evaluation of Real Integrals – Use of Circular Contour.

TOTAL: 60 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Understand the properties of Laplace transforms and to find the Laplace transform of some standard functions. (K3)
- Apply Laplace transform and inverse transform to solve the initial value problems. (K3)
- Solve the multiple integrals and apply the concept to find areas, volumes. (K3)
- Evaluation of line, surface and volume integrals using Green's, Gauss and Stokes theorems. (K3)
- Determine Analytic functions, Bilinear Transformations and apply the concept of conformal mapping to find the images of given curves. (K3)
- Evaluation of Contour Integrals using Cauchy's Integral and Residue theorems. (K3)

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2017.
2. T. Veerarajan., "Engineering Mathematics I", The Tata Mc Graw Hill Publication-New Delhi, First Edition 2018.

REFERENCES:

1. Kreyszig Erwin, "Advanced Engineering Mathematics", John Wiley and Sons, 9th Edition, NewDelhi, 2006.
2. James Stewart, "Calculus, Early Transcendental", Cengage Learning, 7th Edition, New Delhi, 2015.
3. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics II", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.), New Delhi, 9th Edition, 2014.
4. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics II", Narosa Publications, New Delhi, 5th Edition, 2016.
5. Sastry, S.S. "Engineering Mathematics", Vol.I & II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi, 2014.

20BS203	PHYSICS FOR ELECTRONICS ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the essential physics of semiconductor device and electron transport properties.
- To inculcate proficiency in dielectric and optical properties of materials.
- To develop the knowledge on nano electronic devices.

PRE-REQUISITE: NIL**UNIT - I ELECTRICAL PROPERTIES OF MATERIALS 9**

Classical free electron theory: Derivation of electrical conductivity and Thermal conductivity – Wiedemann-Franz law – Success and failures – Quantum free electron theory: Fermi-Dirac statistics – Density of energy states – Electron in periodic potential (Zone theory): Bloch theorem – Energy bands in solids – metals and insulators – tight binding approximation – Electron effective mass – concept of hole.

UNIT - II SEMICONDUCTOR PHYSICS 9

Properties of semiconductors – Energy band diagram – Direct and indirect semiconductors – Intrinsic Semiconductors – Carrier concentration (Derivation) – Variation of Fermi level with temperature – Extrinsic semiconductors – Carrier concentration in N-type & P-type semiconductors (qualitative) – Variation of Fermi level with temperature and carrier concentration – Carrier transport: drift and diffusion transport – Einstein's relation – Hall effect and devices – Zener and avalanche breakdown in p-n junctions – Ohmic contacts – tunnel diode – Schottky diode – MOS capacitor.

UNIT - III DIELECTRIC MATERIALS 9

Basic definitions – polarization processes – Frequency and temperature dependence of polarization – Internal field – Clausius-mosotti relation (derivation) – Dielectric constant experiment – Relation between dielectric constant and Refractive index – dielectric loss – dielectric breakdown – High K dielectric – applications of dielectric (capacitor, transformer) – Ferro electricity and its applications.

UNIT - IV OPTICAL PROPERTIES OF MATERIALS 9

Classification of optical materials – carrier generation and recombination processes – absorption, emission and scattering of light in metals, insulators and semiconductors (concepts only) - photocurrent in a p-n diode – Photo voltaic effect – solar cell and its types – LCD – LED – Organic LED – Laser diodes – Exciton – quantum confined stark effect.

UNIT - V NANO ELECTRONIC DEVICES 9

Quantum structures, Quantum confinement – Density of states in quantum well, quantum wire and quantum dot structures(qualitative) – Band gap of nanomaterials – Quantum size effect – Size dependence of fermi energy – Quantum dot laser – Coulomb blockade effect – single electron transistor (SET) – Magnetic semiconductor – Carbon nanotubes: types, properties and applications.

TOTAL: 45 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Differentiate classical, quantum electron theories and energy band theory. (K2)
- Discuss the properties of semiconductors with applications of the p-n junction and diodes. (K2)
- Explain dielectric properties of materials. (K2)
- Classify optical materials for Opto – electronic applications. (K3)
- Clarify the basic operations of p-n junction devices like solar cells, LED, LCD etc (K2)
- Explain different quantum structures, size effect and carbon nanotubes. (K2)

TEXT BOOKS:

1. B.K.Pandey and S.Chaturvedi, “Engineering Physics”, Cengage learning, 2013.
2. V.Rajendran, “Engineering Physics”, Tata Mc Graw-Hill Education, 2011
3. Charles Kittel, “Introduction to solid state Physics”, John Wiley & sons, 8th edition, 2015.

REFERENCES:

1. G.W. Hanson, “Fundamentals of nano electronics”, Pearson Education, 2009
2. B. Rogers, Adams and S. Pennathur, “Nanotechnology: Understanding Small Systems”, CRC Press, 2019
3. N. Garcia and A. Damask, “Physics for Computer Science Students”, Springer Verlag, 2012.

20CS201	PROGRAMMING IN C	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basic C programming constructs
- To learn about usage of arrays and strings
- To understand the concepts of functions, pointers, structures and unions.
- To expose to file handling operations in C

PRE-REQUISITE: NIL**UNIT - I BASICS OF C PROGRAMMING 9**

Introduction to programming paradigms– Structure of C program– C programming– Data Types, Storage classes, Constants, Enumeration Constants – Keywords, Operators– Precedence and Associativity, Expressions – Input/output statements, Assignment statements –Decision making statements, Switch statement, Looping statements –Pre-processor directives – Compilation process.

UNIT - II ARRAYS AND STRINGS 9

Introduction to Arrays– Declaration, Initialization –One dimensional array –Example Program– Computing Mean, Median and Mode, Two dimensional arrays –Example Program– Matrix Operations (Addition, Scaling, Determinant and Transpose), String operations– length, compare, concatenate, copy –Selection sort, linear and binary search.

UNIT - III FUNCTIONS AND POINTERS 9

Introduction to functions– Function prototype, function definition, function call, Built- in functions (string functions, math functions), Recursion, Example Program– Computation of Sine series, Scientific calculator using built-in functions, Binary Search using recursive functions –Pointers, Pointer operators, Pointer arithmetic, Arrays and pointers – Array of pointers, Example

Program– Sorting of names, Parameter passing– Pass by value, Pass by reference, Example Program– Swapping of two numbers and changing the value of a variable using pass by reference

UNIT - IV STRUCTURES AND UNIONS 9

Structure – Nested structures, Pointer and Structures, Array of structures, Example Program – using structures and pointers, typedef, Self referential structures, Union, Dynamic memory allocation, Illustrative programs – allocating block of memory, sum of n numbers using malloc, calloc.

UNIT - V FILE PROCESSING 9

Files – File operations, Types of file processing– Sequential access, Random access Sequential access file - Example Program– Finding average of numbers stored in sequential access file, Random access file -Example Program– Transaction processing using random access files, Command line arguments.

TOTAL: 45 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Use basic constructs of C programming to develop simple programs. (K3)
- Analyze the one dimensional and two dimensional arrays and develop programs to implement operations such as addition, scaling, Determinant and Transpose. (K3)
- Utilize string operations such as length, compare, concatenate and examine sorting and searching algorithm. (K3)
- Illustrate simple examples for functions and pointers and develop programs to implement pointer arithmetic, arrays with pointers and advanced concepts of functions. (K3)
- Illustrate simple programs for structures and unions and design real time application programs (K4)
- Analyze file operations and develop programs to implement various file access procedures. (K3)

TEXT BOOKS:

1. Balagurusamy, E, "Programming in ANSI C", Eighth Edition, Tata Mcgraw-Hill, 2019.
2. Yashavant Kanetkar, "Let Us C", BPB Publications, 17th Edition, 2020.
3. Kernighan, B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2006.

REFERENCES:

1. Paul Deitel and Harvey Deitel, "C How to Program", Seventh edition, Pearson Education India, 2015.
2. Juneja, B. L and Anita Seth, "Programming in C", CENGAGE Learning India pvt. Ltd., 2011.
3. PradipDey, Manas Ghosh, "Computer Fundamentals and Programming in C", Second Edition, Oxford University Press, 2013.
4. Byron Gottfried, "Schaum's outlines- Programming with C", McGraw-Hill Education, Fourth edition, 2018.
5. Reema Thareja, "Programming in C", Oxford University Press, Second Edition, 2016.

20EE201	ELECTRIC CIRCUIT ANALYSIS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To impart knowledge on solving A.C and D.C Circuits using various laws and theorems.
- To familiarize the concepts of resonance circuits and coupled circuits.
- To educate on obtaining the transient response of circuits.
- To introduce Phasor diagrams and analysis of three phase circuits.

PRE-REQUISITE: NIL**UNIT - I BASIC CIRCUITS ANALYSIS 12**

Ohm's Law – Kirchoff's law – D.C and A.C circuits, Resistors in series and parallel circuits- Voltage and current division rule– Mesh current and node voltage - analysis in DC and AC circuits-average and R.M.S value, Phasor diagram, Power and Power Factor

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

Network reduction: source transformation – star- delta and delta-star transformation, Thevenin's theorem-Norton Theorems – Superposition Theorem — Reciprocity Theorem – Maximum power transfer theorem – Millman's theorem

UNIT - III RESONANCE AND COUPLED CIRCUITS 12

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

UNIT - IV TRANSIENT RESPONSE ANALYSIS 12

Transient response of series RL, RC and RLC Circuits for DC input and A.C. sinusoidal input.

UNIT - V THREE PHASE CIRCUITS 12

Three phase balanced / unbalanced voltage sources - Analysis of three phase 3-wire and 4-wire circuits-three phase balanced star and delta connected load-three phase unbalanced star and delta connected load–phasor diagram of voltage, current and power measurement in three phase circuits.

TOTAL: 60 PERIODS**OUTCOMES:****AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:**

- Apply Kirchhoff's current and voltage laws to simple circuits and Solve complex circuits using Mesh & Nodal Methods. (K3)
- Apply source transformation techniques for analysis of electrical circuit. (K3)
- Apply Network theorems to linear circuits and to solve simple and complex problems. (K3)
- Compute the frequency response of Series and Parallel resonance and analyze tuned circuits. (K3)
- Analyze the Transient response of RLC circuits under DC and AC excitation using Laplace Transform. (K4)
- Analyze three phase balanced and unbalanced star, delta network. (K4)

TEXT BOOKS:

1. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", McGraw Hill, 2015.
2. William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", McGraw Hill publishers, edition, New Delhi, 2013.
3. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", Second Edition, McGraw Hill, 2013.

REFERENCES:

1. Chakrabarti A, "Circuits Theory (Analysis and synthesis), Dhanpath Rai & Sons, New Delhi, 2017.
2. Jegatheesan, R., "Analysis of Electric Circuits," McGraw Hill, 2015.
3. Joseph A. Edminister, Mahmood Nahri, "Electric circuits", Schaum's series, McGraw-Hill, New Delhi, 2010.
4. Mahadevan, K., Chitra, C., "Electric Circuits Analysis," Prentice-Hall of India Pvt Ltd., New Delhi, 2015.

20GE201	ENGINEERING GRAPHICS	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To develop graphic skills for communication of concepts, ideas and design of Engineering products.
- To expose national standards related to technical drawings.

PRE-REQUISITE: NIL

CONCEPTS AND CONVENTIONS (Not for Examination)

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

UNIT - I PROJECTION OF POINTS AND LINES 6+6

Orthographic projection – Principles - Principal planes - Projection of points in all quadrants - 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.

UNIT - II PROJECTION OF PLANE SURFACES 6+6

Projection of planes (Polygonal and Circular surfaces) inclined to both the principal planes by rotating object method.

UNIT - III PROJECTION OF SOLIDS 6+6

Projection of simple solids like prisms, pyramids, cylinder and cone 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+6

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

UNIT - V ISOMETRIC PROJECTION AND FREEHAND SKETCHING 6+6

Principles of Isometric Projection – Isometric scale – Isometric projections of simple solids - truncated Prisms and Pyramids.

Visualization concepts and Free Hand sketching : Principles – Representation of Three Dimensional objects – Layout of views - Freehand sketching of multiple views from pictorial views of objects

TOTAL: 60 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Familiarize with the fundamentals and standards of Engineering graphics. (K2)
- Draw the orthographic projections of points, lines and planes. (K3)
- Draw the projections of simple solids like prisms, pyramids, cylinder and cone. (K3)
- Draw the projections of sectional views of solids and develop its lateral surfaces. (K3)
- Draw the isometric projection of simple objects, truncated prism and pyramids. (K3)
- Draw the free hand sketching of simple objects. (K3)

TEXT BOOKS:

1. Natarajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 30th Edition, 2017.
2. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 15th Edition, 2018.

REFERENCES:

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 53rd Edition, 2019.
2. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson Education, 3rd Edition, 2012.

PUBLICATION OF BUREAU OF INDIAN STANDARDS:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001: Technical drawings - General principles of presentation.
4. IS 11669 – 1986: General principles of dimensioning on technical drawings.
5. SP 46 (2003): Engineering Drawing Practice for Colleges.
6. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

SPECIAL POINTS APPLICABLE TO EXAMINATIONS ON ENGINEERING GRAPHICS:

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day.

20CS2L1	C PROGRAMMING LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To develop programs in C using basic constructs.
- To develop applications in C using strings, pointers, functions, structures.
- To develop applications in C using file processing.

PRE-REQUISITE: NIL**LIST OF PROGRAMS**

1. Programs using I/O statements, expressions and decision-making constructs
2. Program for finding given year is leap year or not and finding given number is Armstrong number or not.
3. Design a calculator to perform the operations namely, addition, subtraction, multiplication, division and square of a number.
4. Given a set of numbers like <10, 36, 54, 89, 12, 27>, find sum of weights based on the following conditions.
 - 5 if it is a perfect cube.
 - 4 if it is a multiple of 4 and divisible by 6.
 - 3 if it is a prime number.
 Sort the numbers based on the weight in the increasing order as shown below
 <10,its weight>,<36,its weight><89,its weight>
5. Matrix addition and subtraction
6. Matrix multiplication and transpose of a matrix
7. Program using string with and without using string functions: string copy and Reverse the String.
8. Convert the given decimal number into binary, octal and hexadecimal numbers using user defined functions.
9. From a given paragraph perform the following using built-in functions:
 - a. Find the total number of words.
 - b. Capitalize the first word of each sentence.
 - c. Replace a given word with another word.
10. Program using recursion – factorial and Fibonacci series
11. Sort the list of numbers using pass by reference.
12. Generate salary slip of employees using structures and pointers.
13. Insert, update, delete and append telephone details of an individual or a company into a telephone directory using random access file.
14. Count the number of account holders whose balance is less than the minimum balance using sequential access file.
15. **Mini project (Any one project : Maximum 4 per Team)**
 - Railway reservation system
 - Library Management System
 - University Result Publication System
 - Hospital Management System
 - Student Automation System
 - Payroll System
 - Banking System
 - Inventory System

PLATFORM NEEDED: Turbo C++ Compiler**TOTAL: 60 PERIODS**

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Develop simple programs using decision making and looping statements. (K3)
- Utilize array concepts to perform matrix addition, subtraction and multiplication. (K3)
- Utilize string operations and develop programs to show string copy and reverse. (K3)
- Develop programs using user defined functions, built-in functions and recursion. (K3)
- Design applications using sequential and random access files. (K3)
- Design simple real time projects using the concepts of structures and union. (K3)

20EE2L2	ELECTRIC CIRCUITS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To simulate various electric circuits using circuit simulation software.
- To gain practical experience on electric circuits and verification of theorems.
- To familiarize the concepts of resonance and coupled circuit experimentally.

PRE-REQUISITE: NIL

LIST OF EXPERIMENTS:

1. Simulation and experimental verification of electrical circuit problems using Ohm's law, Kirchoff's voltage and current 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 verification of Reciprocity theorem.
7. Simulation and experimental determination of time constant of RL and RC series circuits.
8. Study of measurement of self and mutual inductance.
9. Design and Simulation of series & parallel resonance circuit.
10. Simulation of three phase balanced and unbalanced star, delta network.

TOTAL: 60 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Apply Kirchhoff's voltage and current laws to solve simple and complex circuits. (K3)
- Apply network theorems to solve simple and complex circuits. (K3)
- Determine the Time Constant of RC and RL series circuit. (K3)
- Measure self, mutual inductance of a coil. (K3)
- Design and simulate series and parallel resonance circuit. (K3)
- Design and simulate three phase balanced and unbalanced star, delta network. (K3)

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Regulated Power Supply: 0 – 15 V D.C - 10 Nos.
2. Function Generator (1 MHz) - 10Nos.
3. Self and Mutual inductance measurement kit – 2 Nos.
4. 10 Nos. of PC with Circuit Simulation Software (min 10 Users) (e-Sim /Scilab/ Pspice / MATLAB /other Equivalent software Package) and Printer (1No.)
5. AC/DC - Voltmeters (10 Nos.), Ammeters (10 Nos.) and Multi-meters (10Nos.)
6. Decade Resistance Box, Decade Inductance Box, Decade Capacitance Box - 6 Nos each.
7. Circuit Connection Boards - 10 Nos.
8. Oscilloscope (20 MHz) – 5 Nos.
9. Digital storage Oscilloscope (20MHz)-1No.

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

20BS301	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To make the student familiar with the topics such as Fourier Transforms, Z-Transforms and Fourier series.
- To learn the formation of partial differential equations and the solution of first order and higher order partial differential equations.
- To apply Fourier series to solve one dimensional wave, one and two dimensional heat equations which occur frequently in various branches of engineering disciplines.

PRE-REQUISITE: NIL**UNIT - I PARTIAL DIFFERENTIAL EQUATIONS 12**

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

UNIT - II FOURIER SERIES 12

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

UNIT - III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 12

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.

UNIT - IV FOURIER TRANSFORMS 12

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

UNIT - V Z -TRANSFORMS AND DIFFERENCE EQUATIONS 12

Z-transforms - Elementary properties – Inverse Z-transform (using partial fraction and residues) – Initial and final value theorems - Convolution theorem - Formation of difference equations – Solution of difference equations using Z - transform.

TOTAL: 60 PERIODS**OUTCOMES:****AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:**

- Solve the given standard type of first order partial differential equations. (K3)
- Solve linear partial differential equation of second and higher order with constant coefficients. (K3)
- Solve differential equations using Fourier series analysis. (K3)
- Analyze the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equation problems. (K3)
- Compute the Fourier transforms of various functions. (K3)
- Apply Z-transforms techniques for discrete time systems. (K3)

TEXT BOOKS:

1. Grewal .B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2017.
2. Bali.N.P. and Manish Goyal, "A Textbook of Engineering Mathematics", Laxmi Publications Pvt. Ltd, 9th Edition, 2014.

REFERENCES:

1. Erwin Kreyszig, "Advanced Engineering Mathematics ", John Wiley,India, 8th Edition, 2016.
2. James.G., "Advanced Modern Engineering Mathematics", Pearson Education, 3rd Edition, 2007.
3. Andrews.L.C., L.C and Shivamoggi .B, "Integral Transforms for Engineers", SPIE Press, 1999.
4. Narayanan.S., Manicavachagom Pillay.T.K. and Ramanaiah.G, "Advanced Mathematics for Engineering Students", S.Viswanathan Publishers Pvt. Ltd, Chennai, Vol. II 2003 & Vol.III 2002.
5. Ramana.B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Convert different types of codes and the various types of number system, simplify the Boolean functions and gate level minimization and implementation (K2)
- Apply K –Map for simplification and implementation of combinational logic circuit (K3)
- Design the synchronous Sequential logic circuits, draw the block diagram of Shift Registers and Counters. (K3)
- Analyze the asynchronous sequential circuits and explain the hazards & errors in digital circuits. (K3)
- Describe the operation of Programmable Logic Devices and digital logic families (K2)
- Design the VHDL coding for combinational logic and Sequential circuits. (K3)

TEXT BOOKS:

- M. Morris Mano, Michael D. Ciletti, “Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog” Pearson India, 6th Edition, 2018.
- Comer “Digital Logic & State Machine Design, Oxford, 3rd Edition, 2016.
- Thomas L Floyd “Digital Fundamentals” 11th edition, Pearson Education, 2015

REFERENCES:

1. James W. Bignel, Digital Electronics, Cengage learning, 5th Edition, 2007.
2. D.P.Kothari, J.S.Dhillon “Digital Circuits and Design” Pearson Education, 2016
3. Mandal, “Digital Electronics Principles & Application, McGraw Hill Edu, 2013.
4. William Keitz, Digital Electronics-A Practical Approach with VHDL, Pearson,2013
5. Raj Kamal “Digital Systems – Principles and Design” Pearson Education India, 2012.

20EE302	ELECTRON DEVICES AND CIRCUITS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the structure of basic electronic devices.
- Be exposed to active and passive circuit elements.
- To familiarize the operation and applications of electronic devices.
- To explore the gain Vs frequency response characteristics of amplifier.
- To learn the required functionality of positive and negative feedback systems.

PRE-REQUISITE:

Course Code: 20BS203 & 20EE201

Course Name: Physics for Electronics Engineering & Electric Circuit Analysis

UNIT - I PN JUNCTION DEVICES 9

PN junction diode – structure, operation and V-I characteristics, Transition and Diffusion capacitances – Rectifiers – Half Wave and Full Wave Rectifier. Zener diode – reverse characteristics – Zener as voltage regulator, Display devices – LED, Laser diode.

UNIT - II BJT AND SMALL SIGNAL AMPLIFIERS 9

BJT - structure, operation of NPN and PNP transistor, Input and output characteristics of CE, CB and CC configurations. DC Load Line and operating point, Need for biasing - Fixed and Voltage divider biasing. Single stage BJT amplifiers – AC analysis of CE amplifier with Voltage divider bias using h-parameters - Gain and frequency response.

UNIT - III FIELD EFFECT TRANSISTORS AND THYRISTORS 9

JFET, MOSFET - structure, operation and characteristics, Biasing - self and voltage divider biasing. FET small signal model - Analysis of CS and Source follower. Thyristor - SCR operation and characteristics, UJT - operation and characteristics.

UNIT - IV DIFFERENTIAL AMPLIFIERS AND LARGE SIGNAL AMPLIFIERS 9

Cascade amplifier, BJT Differential amplifier – DC and AC analysis of common mode gain, differential mode gain and CMRR - Single tuned amplifier - construction, operation and frequency response. Power amplifiers – class A, class B and class C (Qualitative analysis).

UNIT - V FEEDBACK AMPLIFIERS AND OSCILLATORS 9

Feedback concepts, feedback connections - voltage / current, series / shunt feedback - Transfer gain with feedback - effect of negative feedback on R_i and R_o - Advantages of negative feedback. Positive feedback – Condition for oscillations, RC phase shift, Wien bridge, Hartley, Colpitts and Crystal oscillators.

TOTAL: 45 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the operation and characteristics of PN junction diode, Zener diode, LED and Laser diode. (K2)
- Derive the expression for voltage gain, current gain, input resistance and output resistance of a BJT CE amplifier with voltage divider biasing using h-parameter model. (K3)
- Derive the expression for voltage gain, input resistance and output resistance of FET amplifier under CS and Source follower connection. (K3)
- Explain the operation of cascade amplifier, differential amplifier, single tuned amplifier and power amplifier. (K2)
- Derive the expression for gain with feedback, input resistance and output resistance of different negative feedback connections. (K3)
- Determine the oscillating frequency of RC and LC tuned Oscillators for a specific application. (K3)

TEXT BOOKS:

1. David A. Bell, "Electronic Devices and Circuits", Oxford University press higher education, 5th Edition, 2008.
2. Sedra and Smith, "Microelectronic circuits", 8th Ed., Oxford University Press 2020.
3. Jacob Millman, Christos C Halkias, Satyabrata Jit, 'Electronic Devices and circuits', McGraw Hill education, 4th edition, 2015.

REFERENCES:

1. Balbir Kumar, Shail.B.Jain, "Electronic devices and circuits" PHI learning private limited, 2nd Edition 2014
2. Thomas L.Floyd, "Electronic devices" Conventional current version, Pearson prentice hall, 10th Edition, 2017.
3. Donald A Neamen, "Electronic Circuit Analysis and Design" Tata McGraw Hill, 3rd Edition, 2003
4. Robert Boylestad and Louis Nashelsky., "Electron Device and Circuit Theory" Prentice Hall Private Limited, 11th edition, 2017.
5. S Salivahanan, N Suresh Kumar, "Electronic Devices and Circuits", McGraw Hill Education (India) Private Limited, 4th Edition, 2017.
6. Sedha R.S, "A Text Book of Applied Electronics", S. Chand & company Ltd., Revised edition, 2013.

20EE303	ELECTROMAGNETIC THEORY	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To introduce the basic mathematical concepts related to electromagnetic vector fields
- To impart knowledge on the concepts of
- Electrostatic fields, electrical potential, energy density and their applications.
- Magneto static fields, magnetic flux density, vector potential and its applications.
- Different methods of emf generation and Maxwell's equations
- Electromagnetic waves and characterizing parameters

PRE-REQUISITE:

Course Code: 20BS101, 20BS201 & 20EE201

Course Name: Fundamentals of Engineering Mathematics, Laplace Transform and Advanced Calculus & Electric Circuit Analysis

UNIT - I VECTOR CALCULUS 12

Review of Vector algebra - Introduction to Cartesian, Cylindrical and Spherical coordinate systems - Vector calculus - Differential length, area and volume, line, surface and volume integrals - Del operator - Gradient, Divergence of a vector, Divergence theorem, Curl of a vector, Stokes's theorem - Laplacian of a scalar.

UNIT - II STATIC ELECTRIC FIELDS 12

Coulomb's law - Electric field intensity - Electrical field due to point, Line, Surface and Volume charge distributions - Gauss law and its applications - Absolute Electric potential - Potential difference - Calculation of potential differences for different configurations - Electric dipole - Electrostatic Energy and Energy density - Current and current density - Continuity of current - Boundary conditions of perfect dielectric materials - Permittivity of dielectric materials - Capacitance, Capacitance of different configurations - Poisson's and Laplace's equation - Applications.

UNIT - III STATIC MAGNETIC FIELDS 12

Biot-Savart's Law – Ampere's Circuital Law - Steady magnetic fields produced by current carrying conductors – Magnetic flux and magnetic flux density Scalar and Vector Magnetic potentials Lorentz Force - Magnetic Force and Torque - Nature of magnetic materials - Magnetization and permeability - Magnetic boundary conditions - Magnetic circuits - Inductances and Mutual inductances - Energy density - Applications.

UNIT - IV TIME VARYING FIELDS 12

Faraday's law for Electromagnetic induction- Motional and Transformer EMF- Displacement current, Point form and Integral form of Maxwell's equation- Maxwell's equation in Phasor form - Applications.

UNIT - V ELECTROMAGNETIC WAVES 12

Derivation of Wave Equation - Uniform Plane Waves - Wave equation in Phasor form - Plane waves in lossy dielectrics - Plane waves in free space and in a homogenous material - Wave equation for a conducting medium-Propagation in good conductors - Skin effect - Poynting theorem - Reflection and Refraction of Uniform plane waves - Standing wave ratio - Applications.

TOTAL: 60 PERIODS

-

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Apply the vector calculus to static electromagnetic fields. (K3)
- Apply the principles of electrostatics related to electric field. (K3)
- Apply the principles of electrostatics related to electric potential. (K3)
- Apply the principles of magneto statics related to magnetic field. (K3)
- Apply Maxwell's equations in differential and integral forms. (K3)
- Apply Maxwell's equations to uniform plane wave propagation in different media. (K3)

TEXT BOOKS:

1. Mathew N. O. Sadiku, 'Principles of Electromagnetics', 6th Edition, Oxford University Press Inc. Asian edition, 2015.
2. William H. Hayt and John A. Buck, 'Engineering Electromagnetics', McGraw Hill Special Indian edition, 2014.
3. K A Gangadhar, 'Electromagnetic Field Theory', Khanna Publishers; Eighth Reprint : 2015

REFERENCES:

1. Joseph. A.Edminister, 'Schaum's Outline of Electromagnetics, Third Edition (Schaum's Outline Series), McGraw Hill, 2010.
2. Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill International Editions, Fifth Edition, 2010.
3. J.P.Tewari, 'Engineering Electromagnetics - Theory, Problems and Applications', Second Edition, Khanna Publishers,2013

20EE304

ELECTRICAL MACHINES – I

L	T	P	C
3	1	0	4

OBJECTIVES:

- To understand the Constructional details, the principle of operation, types, performance characteristics and applications of DC generator.
- To understand the Constructional details, the principle of operation, types, performance characteristics and applications of DC motor.
- To explain the need for starters, types and its operation of DC motor and to explain the various methods of testing of DC machines.
- To understand the Constructional details, the principle of operation, types, performance characteristics and applications of Transformer.
- To explain the various types of testing of single phase transformer and types of three phase transformer connections.

PRE-REQUISITE:

Course Code: 20EE201

Course Name: Electric Circuit Analysis

UNIT - I DC GENERATOR**12**

Constructional Details – Working Principle – Types of Armature Winding and Connections – EMF Equation – Methods of Excitation – Characteristics of Series, Shunt and Compound Generators – Armature Reaction and Commutation – Parallel Operation – Losses, Efficiency and Power Stages in DC Generator – Condition for Maximum Efficiency – Applications

UNIT - II DC MOTOR**12**

Principle of Operation – Back EMF – Maximum output power - Torque Equation – Types of DC Motor – Characteristics of Series, Shunt and Compound Motor – Losses, Efficiency and Power Stages in DC Motor – Condition for Maximum Efficiency - Applications.

UNIT - III STARTERS, SPEED CONTROL AND TESTING OF DC MACHINES**12**

Need of starters – two point, three point, four point starters – Speed Control Methods – Separation of No Load Losses – Testing of DC Machines – Brake Test, Swinburne's Test, Retardation Test and Hopkinson's Test. Electric braking – Plugging, dynamic and regenerative braking.

UNIT - IV TRANSFORMER**12**

Constructional Details – Principle of Operation - Types – EMF Equation – Transformation Ratio – Phasor Diagram – Transformer on No Load and Load – Equivalent Circuit – OC and SC Test – Regulation – Parallel Operation – Auto Transformer – Saving of Copper.

UNIT - V TESTING OF TRANSFORMER**12**

Losses and Efficiency in Transformers – Condition for Maximum Efficiency – Testing of Transformers – Polarity Test, Load Test – Phasing out Test – Sumpner's Test – Separation of Losses – All day Efficiency – Three Phase Transformers – Types of Connections.

TOTAL: 60 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Calculate the required field turns and brush adjustment to compensate the armature reaction and explain the construction and working of D.C generator. (K3)
- Analyze the characteristics of D.C motor to identify its applications based on requirement (K3)
- Calculate the required resistance to minimize the starting current of D.C motor and to predetermine the efficiency of d.c machine in different methods (K3)
- Explain the construction and working of transformer for different loading condition with required phasor diagram. (K3)
- Analyze the conversion of two winding transformer into auto transformer for different connection and to calculate increase in efficiency and cost saving (K3)
- Calculate the efficiency of distribution transformer by direct loading and indirect loading (K3)

TEXT BOOKS:

1. Nagrath.I. J and Kothari. D. P., 'Electric Machines', 5th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2017.
2. P.C Sen, 'Principles of Electric Machines and Power Electronics' John Wiley & Sons; 3rd edition 2013.
3. Stephen J. Chapman, 'Electric Machinery fundamentals', 4th edition, McGraw Hill education Pvt. Ltd, 2010.
4. M G Say, 'Alternating Current Machines', 4th edition, Pitman Publishing Limited, 1976.

REFERENCES:

1. Bimbhra P.S. - Electrical Machinery, 1st Edition, Khanna Book Publishing co(P) Ltd, New Delhi, 2021
2. S.K. Bhattacharya, 'Electric Machines' McGraw - Hill education, New Delhi, 3rd edition, 2009.
3. Theodore Wildi., 'Electrical Machines, Drives and Power Systems', Pearson education, (5th Edition), 2002.
4. Sahdev. S.K., 'Electrical Machines', Cambridge University Press, 2018.

20HS301

UNIVERSAL HUMAN VALUES

L	T	P	C
2	1	0	3

OBJECTIVES:

- To create an awareness on Engineering Ethics and Human Values.
- To understand social responsibility of an engineer.
- To appreciate ethical dilemma while discharging duties in professional life.

PRE-REQUISITE: NIL

UNIT - I INTRODUCTION TO VALUE EDUCATION

9

Value Education – Definition - Concept and Need for Value Education - The Evolution of Value Education: Natural acceptance, Self exploration - Fundamentals of value education - Happiness and Prosperity as parts of Value Education- fulfilling human aspirations.

Practice sessions: To discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

UNIT - II HARMONY IN THE HUMAN BEING

9

Human being vs Value education - I' and Body synchronization - Understanding Myself as Co-existence of the Self and the Body - Realization - Self, Body needs - Scanning of Karma -Self and Body- Understanding Sanyam and Health.

Practice sessions: To discuss the role others have played in making material goods available to self. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

UNIT - III HARMONY IN THE FAMILY, SOCIETY AND NATURE

9

Family as a basic unit of Human Interaction-Values in Relationships - The Basics for Trust and Respect in today's Crisis: Affection, e-Guidance, Reverence, Glory, Gratitude and Love –Harmony in society : Resolution, Prosperity, Fearlessness and Co-existence as Comprehensive Human Goal- Harmony in Nature: The Four Orders in Nature - The Holistic Perception of Harmony in Existence.

Practice sessions: To discuss on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education. Gratitude as a universal value in relationship. Discuss with scenarios. Elicit examples from students' lives

UNIT - IV : SOCIAL ETHICS

9

The Basics for Ethical Human Conduct - Defects in Ethical Human Conduct - Holistic Alternative and Universal Order - Universal Human Order and Ethical Conduct - Human Rights violation and Social Disparities.

Practice sessions: To discuss human being as cause of imbalance in nature, pollution, depletion of resources and role of technology

UNIT - V PROFESSIONAL ETHICS

9

Value based Life and Profession - Professional Ethics and Right Understanding - Competence in Professional Ethics - Issues in Professional Ethics – The Current Scenario - Vision for Holistic Technologies, Production System and Management Models.

Practice sessions: To discuss the conduct as an engineer or scientist.

TOTAL: 45 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the significance of value inputs in a classroom and start applying them in their life and profession (AD)
- Distinguish between Values & Skills to ensure happiness and prosperity. (AD)
- Distinguish between Thyself & the Body to ensure competency of an individual. (AD)
- Explain the role of a human being in ensuring harmony in society and nature. (AD)
- Distinguish between ethical and unethical practices, and apply suitable strategy to actualize a harmonious working environment. (AD)
- Develop an awareness of human values to appreciate the rights of others. (AD)

TEXT BOOKS:

1. R.R. Gaur, R. Asthana, G.P. Bagaria, A Foundation Course in Human Values and Professional Ethics, 2nd revised edition, Excel Books, New Delhi, Reprint 2019.
2. A N Tripathy, Human Values, New Age International Publishers, New Delhi, 2003.

REFERENCES:

1. E G Seebauer & Robert L.Berry, Fundamentals of Ethics for Scientists & Engineers, Oxford University Press, 2000.
2. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd, Reprint 2011.
3. Mike Martin and Roland Schinzinger "Ethics in Engineering" McGraw Hill, New York, 4th edition, Reprint 2017.
4. Charles E. Harries, Michael S. Protchard and Michael J. Rabins, "Engineering Ethics-concepts and Cases", Thomson Learning, 2000.
5. S.K. Chakraborty and Dabangshu Chakraborty, "Human Values and Ethics: Achieving Holistic Excellence", ICFAI University Press, 2006.

20EE3L1

ELECTRONICS LABORATORY

L	T	P	C
0	0	3	1.5

OBJECTIVES:

- To understand the behavior of semiconductor devices experimentally.
- To design the amplifiers and oscillators.
- To analyze the rectifier and filters

PRE-REQUISITE: NIL**LIST OF EXPERIMENTS:**

1. Characteristics of Semiconductor diode.
2. Characteristics of Zener diode and Zener as series voltage regulator.
3. Realization of passive filters.
 - Single Phase half-wave and full wave rectifiers with capacitive filters.
 - Characteristics of a BJT under common emitter and common base configurations.
 - Design and testing of Common Emitter amplifier.
 - Characteristics of UJT and generation of saw tooth waveforms.
 - Characteristics of JFET.
 - Differential amplifier using FET.
 - Design and testing of RC phase shift and LC oscillators.
 - Design and testing of Feedback amplifiers (Any one)
 - Simulation of rectifier circuits using PSIM/SIMULINK

TOTAL: 45 PERIODS**OUTCOMES:****AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:**

- Determine the Breakdown voltage, forward and reverse resistance of PN junction diode and Zener diode and calculate the ripple factor of rectifier circuits with filter. (K3)
- Calculate the hybrid parameters of BJT CE and CB configuration from their characteristics. (K3)
- Obtain the frequency response of BJT CE amplifier, feedback amplifier and calculate its bandwidth. (K3)
- Obtain the UJT and JFET parameters from the characteristics and also to calculate the gain of differential amplifier using JFET. (K3)
- Design the RC and LC tuned oscillators for a specific oscillating frequency. (K3)
- Analyze the input and output performance of the given diode based circuit using simulation tools. (K4)

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Semiconductor devices like Diode, Zener Diode, NPN Transistors	Sufficient
2	JFET, UJT	Sufficient
3	Resistors, Capacitors and inductors	Sufficient
4	Function Generators	10 Nos.
5	Regulated Power Supply $\pm 15V$	10 Nos.
6	CRO	10 Nos.
7	Storage Oscilloscope	1 No.
8	Bread boards	Sufficient
Atleast one demo kit for the listed experiment.		

20EE3L2

ELECTRICAL MACHINES LABORATORY – I

L T P C
0 0 3 1.5

OBJECTIVES:

- To analyze the characteristics of D.C motor and D.C generator under actual load test.
- To analyze the characteristics of D.C motor and D.C generator by indirect method
- To analyze the characteristics of transformer by direct and indirect method

PRE-REQUISITE: NIL

LIST OF EXPERIMENTS:

1. Load test on DC Shunt motor & Load test on DC Series motor (Software/Hardware).
2. Load characteristics of DC compound generator.
3. Load test on DC Compound motor (Software/Hardware).
4. Speed Control of DC Motor: Field control, Armature control.
5. Swinburne's test.
6. Open circuit and Load characteristics of DC generator (Self and Separately Excited).
7. Load test on DC series generator.
8. Hopkinson's test.
9. Load test on single phase transformer and Three phase transformer connections.
10. Open circuit & Short circuit test on single phase transformer
11. Sumpner's test.
12. Performance analysis of BLDC motor (MODROB Equipment)

TOTAL: 45 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Select a D.C machine for an application based on the required characteristics (K3)
- Examine the D.C machine to determine and predetermine the performance characteristics
- Explain the different speed control of D.C machines (K3)
- Analyze the performance characteristics of transformer by direct method. (K3)
- Estimate the transformer parameters by indirect method. (K3)
- Examine the losses in transformer for various load condition and to find efficiency. (K3)

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	NAME OF THE EQUIPMENT	Qty.
1.	DC Shunt Motor with Loading Arrangement	3 Nos.
2.	Single Phase Transformer	4 Nos.
3.	DC Series Motor with Loading Arrangement	1 No.
4.	DC compound Motor with Loading Arrangement	1 No.
5.	DC Shunt Motor Coupled With DC Compound Generator	2 Nos.
6.	DC Shunt Motor Coupled With DC Shunt Motor	1 No.
7.	Tachometer -Digital/Analog	8 Nos.
8.	Single Phase Auto Transformer	2 Nos.
9.	Three Phase Auto Transformer	1 No.
10.	Single Phase Resistive Loading Bank	2 Nos.

20BS402

NUMERICAL METHODS

L	T	P	C
3	1	0	4

OBJECTIVES:

- To introduce the basic concepts to Solving Algebraic and Transcendental Equations.
- To make the Student familiarize with the Concept of Numerical Techniques of Interpolation, Differentiation and Integration.
- To understand the various Techniques and Methods of Solving Ordinary Differential Equations and Partial Differential Equations.

PRE-REQUISITE: NIL**UNIT - I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 12**

Solution of Algebraic and Transcendental Equations - Fixed Point Iteration Method – Newton Raphson Method -Solution of Linear System of Equations - Gauss Elimination Method – Pivoting - Gauss Jordan Method – Iterative Methods of Gauss Jacobi and Gauss Seidel – Eigen Values of a Matrix by Power Method and Jacobi's Method for Symmetric Matrices.

UNIT - II INTERPOLATION AND APPROXIMATION 12

Interpolation with Unequal Intervals - Lagrange's Interpolation – Newton's Divided Difference Interpolation – Cubic Splines - Difference Operators and Relations - Interpolation with Equal Intervals - Newton's Forward and Backward Difference Formulae.

UNIT - III NUMERICAL DIFFERENTIATION AND INTEGRATION 12

Approximation of Derivatives using Interpolation Polynomials - Numerical Integration using Trapezoidal, Simpson's 1/3 Rule – Romberg's Method - Two point and Three point Gaussian Quadrature Formulae – Evaluation of Double Integrals by Trapezoidal and Simpson's 1/3 Rules.

UNIT - IV INITIAL VALUE PROBLEMS FOR 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 Equations - Multi Step Methods - Milne's and Adams – Bash Forth Predictor Corrector Methods for Solving First Order Equations.

UNIT - V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 12

Finite Difference Methods for Solving Second Order Two - Point Linear Boundary Value Problems - Finite Difference Techniques for the Solution of Two Dimensional Laplace's and Poisson's Equations on Rectangular Domain – One Dimensional Heat Flow Equation by Explicit and Implicit (Crank Nicholson) methods – One Dimensional Wave Equation by Explicit Method.

TOTAL: 60 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Solve Algebraic and Transcendental equations. (K3)
- Apply Newton's forward, backward and Lagrange's formula for interpolation with equal and unequal intervals. (K3)
- Compute derivatives using Newton's forward and backward interpolation formulae. (K3)
- Apply Numerical Integration for Single Variable and Two Variable Functions. (K3)
- Solve Initial Value Problem using Single Step and Multi Step Methods. (K3)
- Solve the Boundary Value Problem using Finite Difference Methods. (K3)

TEXT BOOKS:

1. Grewal.B.S., "Numerical Methods in Engineering and Science", Khanna Publishers, New Delhi, 10th Edition, 2015.
2. Sastry. S.S, "Introductory Methods of Numerical Analysis", PHI Learning Pvt.Ltd, 5th Edition, 2018.

REFERENCES:

1. Burden.R.L and Faires.J.D, "Numerical Analysis", Cengage Learning, 9th Edition,2016.
2. Gerald. C. F. and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia, New Delhi, 7th Edition, 2006.
3. Mathews. J.H. "Numerical Methods for Mathematics, Science and Engineering", Prentice Hall, 2nd Edition, 1992.
4. Sankara Rao. K., "Numerical Methods for Scientists and Engineers", Prentice Hall of India Pvt. Ltd, 5th Edition, New Delhi, 2007.
5. Veerarajan.T, Ramachandran. T, "Numerical Methods With Programs In C", Tata Mcgraw Hill Publishing Company Limited, 8th Edition, Reprint 2011.

20EE401

ELECTRICAL MACHINES - II

L	T	P	C
3	1	0	4

OBJECTIVES:

- To learn the construction and performance of salient and non – salient type synchronous generators.
- To analyze the operation and performance of synchronous motor.
- To learn the construction, principle of operation and performance of induction machines.
- To learn the starting and speed control of three-phase induction motors.
- To analyze the operation and performance of single phase induction motors and special machines.

PRE-REQUISITE:

Course Code: 20EE201, 20EE303 & 20EE304

Course Name: Electric Circuit Analysis, Electromagnetic Theory & Electrical Machines – I.

UNIT - I SYNCHRONOUS GENERATOR

12

Constructional Details – Types of Rotors – EMF Equation – Synchronous Reactance – Armature Reaction – Voltage Regulation – EMF, MMF and ZPF Methods – Synchronizing and Parallel Operation – Synchronizing Power - Power Output Equations - Change of Excitation and Mechanical Input.

UNIT - II SYNCHRONOUS MOTOR

12

Principle of Operation – Torque Equation – Starting Methods -Operation on Infinite Bus bars – V and Inverted V Curves – Input and Output Power Equations – Power Angle Relations – Hunting - Synchronous Condenser - Applications.

UNIT - III THREE PHASE INDUCTION MOTOR

12

Constructional Details – Types of Rotors – Squirrel Cage and Slip Ring – Principle of Operation – Slip –Torque Equations -Slip-Torque Characteristics – Losses and Efficiency – Load Test - No Load and Blocked Rotor Tests - Equivalent Circuit- Circle Diagram – Separation of No Load Losses – Crawling and Cogging – Double Cage Rotors – Induction Generator.

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

12

Need for Starters – Types of Starters – Stator Resistance, Rotor Resistance, Autotransformer, Star-Delta Starters and DOL Starters - Speed Control by Varying Voltage, Frequency, Poles and Rotor Resistance – Slip Power Recovery Scheme.

UNIT - V SINGLE PHASE INDUCTION MOTOR AND SPECIAL MACHINES

12

Constructional Details –Types of single phase motors– Double Revolving Field Theory – No Load and Blocked Rotor Tests - Equivalent Circuit – Starting Methods – Applications. Special machines – Linear Induction Motor, Hysteresis motor, Brushless DC Motor.

TOTAL: 60 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Calculate the Voltage regulation of Synchronous generator in Different methods and explain the construction details of alternator. (K3)
- Analyze the sharing of Real and Reactive power in Parallel operation and explain the V and Inverted V curve of Synchronous machine. (K3)
- Analyze the torque-slip characteristics and explain the construction and working principle of three phase induction motor. (K4)
- Analyze the efficiency of three phase induction motor for different slip using equivalent circuit. (K3)
- Compare and calculate the starting torque and current of three phase induction motor for different starters and Explain the speed control of three phase induction motor. (K3)
- Calculate the efficiency for different slip using equivalent circuit and explain the construction and working principle of single phase induction motor (K3)

TEXT BOOKS:

1. Nagrath.I. J and Kothari. D. P., 'Electric Machines', 5th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2017.
2. P.C Sen, 'Principles of Electric Machines and Power Electronics' John Wiley & Sons; 3rd edition 2013.
3. Stephen J. Chapman, 'Electric Machinery fundamentals' 4th edition, McGraw Hill education Pvt. Ltd, 2010.
4. M G Say, 'Alternating Current Machines', 4th edition, Pitman Publishing Limited, 1976.

REFERENCES:

1. Bimbira P.S. - Electrical Machinery, 1st Edition, Khanna Book Publishing co(P) Ltd, New Delhi, 2021
2. S.K. Bhattacharya, 'Electric Machines' McGraw - Hill education, New Delhi, 3rd edition, 2009.
3. Theodore Wildi., 'Electrical Machines, Drives and Power Systems', Pearson education, (5th Edition), 2002.
4. Sahdev. S.K., 'Electrical Machines', Cambridge University Press, 2018.

20EE402	TRANSMISSION AND DISTRIBUTION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the structure of electric power system and to develop expressions for the Computation of transmission line parameters
- To obtain the equivalent circuits for the transmission lines based on distance and to determine voltage regulation and efficiency.
- To understand the mechanical design of transmission lines and to analyze the voltage distribution in insulator strings to improve the efficiency.
- To study the types, construction of cables and methods to improve the efficiency.
- To study about distribution systems, types of substations, methods of grounding, EHVAC, HVDC and FACTS

PRE-REQUISITE:

Course Code: 20EE201 & 20EE303

Course Name: Electric Circuit Analysis & Electromagnetic Theory

UNIT - I TRANSMISSION LINE PARAMETERS 9

Structure of Power System - Parameters of single and three phase transmission lines with single and double circuits -Resistance, inductance and capacitance of solid, stranded and bundled conductors, Symmetrical and unsymmetrical spacing and transposition – application of self and mutual GMD; skin and proximity effects -Typical configurations, conductor types and electrical parameters of EHV lines.

UNIT - II MODELLING AND PERFORMANCE OF TRANSMISSION LINES 9

Performance of Transmission lines - short line, medium line and long line – equivalent circuits, phasor diagram, attenuation constant, phase constant, surge impedance -transmission efficiency and voltage regulation, real and reactive power flow in lines – Power Circle diagrams -Formation of Corona – Critical Voltages – Effect on Line Performance.

UNIT - III MECHANICAL DESIGN OF LINES 9

Mechanical design of OH lines – Line Supports –Types of towers – Stress and Sag Calculation – Effects of Wind and Ice loading. Insulators: Types, voltage distribution in insulator string, improvement of string efficiency, testing of insulators.

UNIT - IV UNDER GROUND CABLES 9

Underground cable - Types of cables – Construction of single core and 3 core Cables -Insulation Resistance – Potential Gradient - Capacitance of Single-core and 3 core cables- Grading of cables - Power factor and heating of cables– DC cables.

UNIT - V DISTRIBUTION SYSTEMS 9

Distribution Systems – General Aspects – Kelvin’s Law – AC distribution System – Connection schemes-radial and ring main-Interconnected system-Techniques of Voltage Control and Power factor improvement – Distribution Loss –Types of Substations - Methods of Grounding – Trends in Transmission and Distribution: EHVAC, HVDC and FACTS (Qualitative treatment only).

TOTAL: 45 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Calculate the transmission network parameters for various configuration. (K3)
- Predict the performance of transmission line. (K3)
- Calculate the sag of transmission line (K3)
- Calculate the voltage distribution in insulator strings and determine the string efficiency of insulator. (K3)
- Compute the electrical parameter of underground cable. (K3)
- Explain the types of distribution system. (K2)

TEXT BOOKS:

1. D.P.Kothari, I.J. Nagarath, 'Power System Engineering', Tata McGraw-Hill Publishing Company limited, New Delhi, Second Edition, 2008.
2. C.L.Wadhwa, 'Electrical Power Systems', New Academic Science Ltd, 2016.
3. S.N. Singh, 'Electric Power Generation, Transmission and Distribution', Prentice Hall of India Pvt. Ltd, New Delhi, Second Edition, 2011.

REFERENCES:

1. B.R.Gupta , "Power System Analysis and Design", S. Chand, New Delhi, Fifth Edition, 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, 2016.
3. V.K.Mehta, Rohit Mehta, 'Principles of power system', S. Chand & Company Ltd, New Delhi, 2013

20EE403	LINEAR INTEGRATED CIRCUITS AND APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To discuss the IC fabrication procedure.
- To learn the characteristics of Op-Amp.
- To design and construct the basic applications of Op-amp.
- To interpret the internal functional blocks and the applications of special ICs.
- To illustrate the operation of application ICs.

PRE-REQUISITE:

Course Code: 20EE201 & 20EE302

Course Name: Electric Circuit Analysis & Electron Devices and Circuits

UNIT - I IC FABRICATION 9

IC classification - fundamentals of monolithic IC technology – basic planar processes - fabrication of typical circuit - Fabrication of diodes, resistance, capacitance and FETs.

UNIT - II CHARACTERISTICS OF OP-AMP 9

Ideal Op-Amp - DC and AC characteristics - Basic applications of Op-Amp – Inverting and Non-inverting Amplifiers, summer, differential amplifier, differentiator and integrator - V/I and I/V converters.

UNIT - III APPLICATIONS OF OP-AMP 9

Op-Amp circuits using Diodes - peak detector, clippers, clampers - Instrumentation amplifier - S/H circuit – comparators - multivibrators - waveform generators – First order Low pass and high pass active filters - D/A converter (R- 2R ladder and weighted resistor types) - A/D converter (Flash and Successive approximation types).

UNIT - IV SPECIAL ICs 9

555 Timer - Functional block, characteristics – IC NE/SE 566 Voltage Controlled Oscillator - IC NE/SE 565 Phase Locked Loop – AD633 Analog multiplier and Divider.

UNIT - V APPLICATION ICs 9

IC voltage regulators – LM78XX, LM79XX series voltage regulator - LM317, 723 Variability voltage regulators – μ A78S40 switching regulator - LM 380 power amplifier - ICL 8038 function generator IC.

TOTAL: 45 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the IC fabrication process and discuss the fabrication of active and passive components. (K2)
- Compute the gain and output voltage of the given Op-Amp circuits. (K3)
- Determine the oscillating/cutoff frequency of waveform generators and filters and also discuss the operation of Op-Amp circuits using diodes. (K3)
- Discuss the internal functional blocks and applications of special ICs 555, 566, 565, and AD633 ICs. (K2)
- Explain the operation of voltage regulator ICs namely LM78XX, LM79XX, LM317 and LM723. (K2)
- Discuss the operation of μ A78S40 switching regulator, LM 380 power amplifier and ICL 8038 function generator IC. (K2)

TEXT BOOKS:

1. David A. Bell, 'Operational Amplifiers and Linear ICs, Oxford higher education, 2013.
2. D. Roy Choudhury, Shail B. Jain, "Linear Integrated Circuits", 5th Edition, New Age, 2018.
3. Ramakant A. Gayakward, "Op–Amps and Linear Integrated Circuits", 4th Edition, PHI, 2015.

REFERENCES:

1. Fiore, 'Opamps & Linear Integrated Circuits Concepts & applications', Cengage, 2018.
2. Robert F.Coughlin, Fredrick F. Driscoll, 'Op-amp and Linear ICs', Pearson, 6th edition, 2012.
3. Muhammad H. Rashid, 'Microelectronic Circuits Analysis and Design' Cengage Learning, 2011.
4. Floyd , Buchla, 'Fundamentals of Analog Circuits', Pearson, 2013.
5. Jacob Millman, Christos Halkias, Chetan D Parikh, 'Integrated Electronics – Analog and Digital circuits system', McGraw Hill, 2nd edition, 2017.
6. Sergio Franco, 'Design with Operational Amplifiers and Analog Integrated Circuits', Mc Graw Hill, 2016.

20EE404	MEASUREMENTS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the basic functional elements of instrumentation
- To introduce the fundamentals of electrical and electronic instruments
- To educate on the comparison between various measurement techniques
- To introduce various storage and display devices
- To introduce various transducers and the data acquisition systems.

PRE-REQUISITE:

Course Code: 20EE201

Course Name: Electric Circuit Analysis

UNIT - I INTRODUCTION 9

Functional elements of an instrument – Static and dynamic characteristics – Errors in measurement – Statistical evaluation of measurement data – Standards and calibration.

UNIT - II ELECTRICAL AND ELECTRONICS INSTRUMENTS 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-1 ϕ Induction type Energy meter.

UNIT - III COMPARISON METHODS OF MEASUREMENTS 9

D.C potentiometers - Crompton Potentiometer, D.C (Wheatstone, Kelvin, Kelvin double) bridges & A.C (Maxwell, Anderson, Hay's, Wein & Schering) bridges, transformer ratio bridges, self-balancing bridges.

UNIT - IV STORAGE AND DISPLAY DEVICES 9

Magnetic disk and tape – Recorders, digital plotters and printers, CRT display, digital CRO, LED, LCD & Dot matrix display – Elements of data acquisition system - Data Loggers.

UNIT - V TRANSDUCERS AND DATA ACQUISITION SYSTEMS 9

Classification of transducers – Selection of transducers – Resistive Transducer – Strain guage, Measurement of Temperature - RTD, thermister & thermocouple, Capacitive transducer - Inductive Transducers – Linear Variable Differential Transducer, Piezoelectric, Hall effect, optical and digital transducers — Smart sensors-Thermal Imagers, Power factor meter - Harmonic analyzer - Spectrum analyzer

TOTAL: 45 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Compute the different statistical analysis on errors.(K3)
- Explain the concepts of fundamentals of electrical and electronic instruments (K2)
- Classify AC and DC bridges and formulate balance equation to calculate unknown resistance, inductance and capacitance. (K3)
- Discuss the interference and classify grounding techniques. (K2)
- Explain the various storage and display devices. (K2)
- Explain the construction and working of different types of transducer. (K2)

TEXT BOOKS:

1. A.K. Sawhney, 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2017.
2. J. B. Gupta, 'A Course in Electronic and Electrical Measurements', S. K. Kataria & Sons, Delhi, 2018.
3. H.S. Kalsi, 'Electronic Instrumentation', McGraw Hill, 4th Edition 2019.

REFERENCES:

1. E.O. Doebelin, Dhanesh N Manik, 'Measurement Systems' 7th Edition, McGraw Hill publishing company, 2019.
2. R.K. Rajput, 'Electrical and Electronics Measurements and Instrumentation', S. Chand Publications, New Delhi, 4th Edition, 2016.
3. Alan. S. Morris, 'Measurement and Instrumentation: Theory and Application', Prentice Hall of India, 2nd Edition, 2015.
4. David Bell, 'Electronic Instrumentation & Measurements', Oxford University Press, 2013.
5. D.V.S. Murthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2015

20HS401	ENVIRONMENTAL SCIENCE AND ENGINEERING	L	T	P	C
		2	0	0	2

OBJECTIVES:

- To study the scope and significance of environment
- To study the interrelationship between living organism and environment
- To know about conservation of biodiversity
- To get a conceptual knowledge on various types of pollution
- To gain knowledge on various natural resources
- To provide knowledge on natural disasters and its management
- To learn social issues such as human welfare, sustainability related to population

PRE-REQUISITE: NIL

UNIT - I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 6

Environment – definition, importance, public awareness Ecosystem – concept, structure and function – producers, consumers and decomposers - characteristic features, structure and function of the forest ecosystem and grassland ecosystem. Biodiversity – definition, types - genetic, species and ecosystem diversity – values - consumptive use, productive use, social, ethical, aesthetic and option values – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife – endangered and endemic species of India – Assignment on conservation of biodiversity.

UNIT - II ENVIRONMENTAL POLLUTION 6

Definition, causes, effects and control measures of (i) Air pollution (ii) Water pollution (iii) Soil pollution (iv) Marine pollution – role of an individual in prevention of pollution – pollution case studies - Climate change - global warming, acid rain, ozone layer depletion.

UNIT - III NATURAL RESOURCES 6

Forest resources: Uses, over-exploitation, deforestation, case studies Water resources: Surface water and ground water - uses, over-utilization, conflicts over water, Conservation of water - rain water harvesting, dams-benefits and problems. Mineral resources: uses, over exploitation, environmental effects of extracting mineral resources, case studies.

UNIT - IV SOLID WASTE AND DISASTER MANAGEMENT 6

Solid waste management Introduction, types, effects on human beings and disposal management. Disaster management Introduction, causes, effects and management of flood, cyclone, earthquake, landslide disasters – case studies- roles and responsibilities of Government and community

UNIT - V HUMAN POPULATION AND SOCIAL ISSUES 6

Population growth, population explosion – family welfare programme – women and child welfare – human rights – value education – sustainable development – resettlement and rehabilitation – waste land reclamation – role of information technology in environment and human health. Debate on women and child welfare.

TOTAL: 30 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Describe the environment, ecosystem and their significances (K2)
- Identify the threats to biodiversity and methods to conserve biodiversity (K2)
- Identify and implement technological and economical solution to environmental pollution (K2)
- Develop the knowledge on various natural resources and effect on environment due to over utilization (K2)
- Record the consequences of natural disasters (K2)
- Outline the social issues such as welfare, sustainability etc., and to relate with population growth (K2)

TEXT BOOKS:

1. Anubha Kaushik and Kaushik C.P., Environmental Science and Engineering, New Age International (P) Ltd, Sixth Edition, 2018.
2. Benny Joseph, Environmental Science and Engineering, Tata McGraw-Hill Publishing Company Ltd, New Delhi, ISBN: 0070601690, 2006.

REFERENCES:

1. Erach Bharucha, "Text book of Environmental Studies", Universities Press (I) PVT LTD, Hyderabad, 2015
2. G. Tyler Miller and Scott E.Spoolman, "Environmental Science", Cengage Learning India PVT, LTD, Delhi, 2014
3. Gilbert M.Masters, "Introduction to Environmental Engineering and Science", 2nd edition, Pearson Education, 2004

20EE4L1

ELECTRICAL MACHINES LABORATORY – II

L	T	P	C
0	0	3	1.5

OBJECTIVES:

- To analyze the voltage regulation of synchronous machine in different methods
- To analyze the performance characteristics of three phase and single phase induction motor using equivalent circuit
- To analyze the characteristics of synchronous machines for various excitation

PRE-REQUISITE: NIL**LIST OF EXPERIMENTS:**

1. Regulation of three-phase alternator by EMF and MMF methods.
2. Regulation of three phase alternator by ZPF method.
3. Load test on three-phase alternator.
4. V and inverted V curves of three phase synchronous motor.
5. Load test on three phase induction motor
6. No load and blocked rotor test on three phase induction motor.
7. Load test on single phase induction motor
8. Determination of equivalent circuit of single phase induction motor
9. Synchronization of three phase alternator with bus bar.
10. Separation of no-load losses of three-phase induction motor.
11. Measurement of starting current of AC motors with different starter using Power Quality Analyzer
12. Performance analysis of Synchronous Reluctance motor (MODROB equipment)

TOTAL: 45 PERIODS**OUTCOMES:****AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:**

- Examine the given synchronous machine and to pre determine the voltage regulation by different methods. (K4)
- Calculate voltage regulation alternator by direct loading. (K4)
- Analyze the power factor of synchronous motor for various excitations. (K3)
- Calculate the efficiency by direct loading. (K3)
- Calculate the performance characteristics using equivalent circuit of single and three phase induction motor (K3)
- Analyze the constant losses induction motor for various frequency (K3)

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	NAME OF THE EQUIPMENT	Qty.
1.	Synchronous Induction motor 3HP	1 No.
2.	DC Shunt Motor Coupled With Three phase Alternator	4 Nos.
3.	DC Shunt Motor Coupled With Three phase Slip ring Induction motor	1 No.
4.	Three Phase Induction Motor with Loading Arrangement	2 Nos.
5.	Single Phase Induction Motor with Loading Arrangement	2 Nos.
6.	Tachometer -Digital/Analog	8 Nos.
7.	Single Phase Auto Transformer	2 Nos.
8.	Three Phase Auto Transformer	3 Nos.
9.	Single Phase Resistive Loading Bank	2 Nos.
10.	Three Phase Resistive Loading Bank	2 Nos.
11.	Capacitor Bank	1 No.

20EE4L2	LINEAR AND DIGITAL INTEGRATED CIRCUITS LABORATORY	L 0	T 0	P 3	C 1.5
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OBJECTIVES:

- To design, test and characterize circuit behavior with digital and analog ICs.
- To design and test various combinational and sequential circuits.
- To introduce the functions of counter, shift register.
- To interpret and realize the basic applications of Op-amp and timer.
- To explain the behavior of special ICs.

PRE-REQUISITE:

Course Code: 20EE301
Course Name: Digital Logic Circuits

LIST OF EXPERIMENTS:

1. Implementation of Boolean Functions, Adder and Subtractor circuits.
2. Implementation of Binary to Gray code converter and vice-versa.
3. Implementation of Encoders, Decoders, Parity generator and parity checking.
4. Implementation of multiplexer and de multiplexer.
5. Implementation of Shift Registers: SISO, SIPO, PISO, PIPO modes.
6. Implementation of Counters: synchronous and Asynchronous types (Any two).
7. Design and testing of inverting and non-inverting amplifier, Adder,
8. Design and testing of comparator, Integrator and Differentiator.
9. Design and testing of Astable and Monostable operation using 555 timer.
10. Verification of Voltage to frequency characteristics of NE/ SE 566 IC.
11. Verification of Variability Voltage Regulator using IC LM317/LM723.
12. Simulation of inverting and Non-inverting Amplifier using PSPICE/SIMULINK

TOTAL: 45 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Design and implement the combinational logic circuit for the given Boolean function. (K3)
- Design and verify the truth table of sequential logic circuits (code converters, parity generator, parity checker, encoders, decoders, multiplexer and demultiplexer). (K3)
- Design and implement the Counters and Shift registers. (K3)
- Design and testing of Op-Amp circuits (inverting amplifier, non inverting amplifier, adder, comparator, integrator and differentiator). And also analyze the input and output performance of the op-amp based circuit using simulation tools. (K3)
- Graph the astable and monostable mode response using Timer IC NE/SE 555. (K3)
- Testing of IC NE/SE 566 to show the voltage to frequency characteristics of VCO and to manipulate the variability voltage regulator using IC LM317. (K4)

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS: (3 per Batch)

S. No	Name of the equipments / Components	Quantity Required	Remarks
1	Dual, (0-30V) variability Power Supply	10	-
2	CRO	9	30 MHz
3	Digital Multimeter	10	Digital
4	Function Generator	8	1 MHz
5	IC Tester (Analog)	2	-
6	Bread board	10	-
7	Computer (PSPIICE installed)	1	-
Consumables (sufficient quantity)			
1	IC 741/ IC NE555/566/565		
2	Digital IC types		
3	LED		
4	LM317		
5	LM723		
6	ICSG3524 / SG3525		
7	Transistor – 2N3391		
8	Diodes, IN4001, BY126		
9	Zener diodes		
10	Potentiometer		
11	Step-down transformer 230V/12-0-12V		
12	Capacitor		
13	Resistors 1/4 Watt Assorted		
14	Single Strand Wire		

20EE4L3

TECHNICAL SEMINAR

L	T	P	C
0	0	2	1

OBJECTIVES:

- To encourage the students to study advanced engineering developments in the emerging areas
- To prepare and present technical reports.
- To encourage the students to use various teaching aids such as, power point presentation, Videos and demonstrative models.

PRE-REQUISITE: NIL

METHOD OF EVALUATION:

During the seminar session each student is expected to prepare and present a topic on engineering/ technology/emerging areas, for duration of about 8 to 10 minutes. In a session of two periods per week, 15 students are expected to present the seminar. Each student is expected to present atleast twice during the semester and the student is evaluated based on that. At the end of the semester, he / she can submit a report on his / her topic of seminar and marks are given based on the report. A Faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also. Evaluation is 100% internal.

TOTAL: 30 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Review, prepare and present technological developments (K4)
- Face the placement interviews (K3)

20EE501	POWER SYSTEM ANALYSIS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To model the power system under steady state operating condition.
- To apply numerical methods to solve the power flow problem.
- To model and analyze the system under symmetrical faulted conditions.
- To model and analyze the system under unsymmetrical faulted conditions.
- To model and analyze the transient behaviour of power system when it is subjected to a fault.

PRE-REQUISITE:

Course Code: 20EE201, 20EE402, 20BS402
 Course Name: Electric Circuit Analysis, Transmission and Distribution, Numerical Methods

UNIT - I INTRODUCTION 12

Need for system planning and operational studies – basic components of a power system - Introduction to restructuring - Single line diagram – per phase and per unit analysis – Generator - transformer – transmission line and load representation for different power system studies - Primitive network - construction of Y-bus using inspection and singular transformation methods.

UNIT - II POWER FLOW ANALYSIS 12

Importance of power flow analysis in planning and operation of power systems - statement of power flow problem - classification of buses - development of power flow model in complex variables form - iterative solution using Gauss-Seidel method - Q-limit check for voltage controlled buses – power flow model in polar form - iterative solution using Newton-Raphson method - Fast Decoupled load flow algorithm.

UNIT - III FAULT ANALYSIS – BALANCED FAULTS 12

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

UNIT - IV FAULT ANALYSIS – UNBALANCED FAULTS 12

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

UNIT - V STABILITY ANALYSIS 12

Importance of stability analysis in power system planning and operation - classification of power system stability - angle and voltage stability – Single Machine Infinite Bus (SMIB) system: Development of swing equation - equal area criterion - determination of critical clearing angle and time– solution of swing equation by modified Euler method and Runge-Kutta fourth order method - Recent trends in analysis of power system stability.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Nagrath I.J. and Kothari D.P., 'Modern Power System Analysis', Tata McGraw-Hill, Fourth Edition, 2011.
2. John J. Grainger and W.D. Stevenson Jr., 'Power System Analysis', Tata McGraw-Hill, Sixth reprint, 2017.

REFERENCES:

1. P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan, 'Electrical Power Systems - Analysis, Security and Deregulation', PHI Learning Private Limited, New Delhi, 2012.
2. Kundur P., 'Power System Stability and Control', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 10th reprint, 2010.
3. Pai M A, 'Computer Techniques in Power System Analysis', Tata Mc Graw-Hill Publishing Company Ltd., New Delhi, Second Edition, 2007.
4. Hadi Saadat, 'Power System Analysis', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010
5. Olle. I. Elgerd, 'Electric Energy Systems Theory – An Introduction', Tata McGraw Hill Publishing Company Limited, New Delhi, Second Edition, 2012.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Apply the mathematical and engineering knowledge to form bus admittance matrix and impedance matrix (K3)
- Apply Gauss-Seidel and Newton Raphson methods to solve the load flow problem (K3)
- Analyze the power system under steady state symmetrical fault(K4)
- Analyze the power system under unsymmetrical faults (K4)
- Analyze the transient stability of the power system using equal area criterion (K4)
- Analyze the transient stability of the power system using swing equation (K4)

20EE502

POWER ELECTRONICS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the various applications of Power electronic devices for conversion, control and conditioning of the electrical power and to get an overview of different types of power semiconductor devices and their dynamic characteristics.
- To understand the operation, characteristics and performance parameters of controlled rectifiers.
- To study the operation, switching techniques and basics topologies of DC-DC switching regulators.
- To learn the different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.
- To study the operation of AC voltage controller and various configurations of AC voltage controller.

PRE-REQUISITE:

Course Code: 20EE302

Course Name: Electron Devices and Circuits

UNIT - I POWER SEMI-CONDUCTOR DEVICES 9

Study of switching devices, SCR, TRIAC, GTO, BJT, MOSFET, IGBT and IGCT- Static characteristics: SCR, MOSFET and IGBT - Triggering and commutation circuit for SCR, Introduction to Driver and snubber circuits.

UNIT - II PHASE-CONTROLLED CONVERTERS 9

2-pulse, 3-pulse and 6-pulse converters – performance parameters – Effect of source inductance – Firing Schemes for converter – Dual converters, Applications - light dimmer, Excitation system, Solar PV systems.

UNIT - III DC TO DC CONVERTERS 9

Step-down and step-up chopper - control strategies - Buck, Boost, and Buck-Boost - Performance analysis - PWM techniques for choppers - Switched mode regulators – Applications - Battery operated vehicles.

UNIT - IV INVERTERS 9

Single phase and three phase voltage source inverters (both 120° mode and 180° mode) – Voltage & harmonic control - PWM techniques: Multiple PWM, Sinusoidal PWM, modified sinusoidal PWM – Introduction to space vector modulation – Current source inverter, Applications - Induction heating, UPS.

UNIT - V AC TO AC CONVERTERS 9

Single phase and Three phase AC voltage controllers – Control strategy - Power Factor Control – Multistage sequence control - single phase and three phase cyclo converters – Introduction to Matrix converters, Applications – welding.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Muhammad H.Rashid, 'Power Electronics Circuits, Devices & Applications', 4th Edition, Pearson India, 2017
2. P.S.Bimbra, 'Power Electronics', Khanna Publishers, Fifth Edition, 2014.
3. Joseph Vithayathil, 'Power Electronics, Principles and Applications', McGraw Hill Series, 6th Reprint, 2013.

REFERENCES:

1. Ned Mohan, Tore.M.Undeland, William.P.Robbins, 'Power Electronics: Converters, Applications and Design', 3rd Edition Wiley India, New Delhi, 2007.
2. M.D.Singh & K.B Khanchandani, 'Power Electronics', 2nd Edition, Tata McGraw Hill Publishing Co.Ltd., New Delhi, 2008.
3. D. Ronanki, S. Singh, S. Williamson, 'Comprehensive Topological Overview of Rolling Stock Architectures and Recent Trends in Electric Railway Traction Systems', IEEE Trans. Transportation Electrification., vol. 3, no. 3, pp. 724-738, May 2017.
4. JP Agarwal, 'Power Electronic Systems: Theory and Design', 1e, Pearson Education, 2002.
5. Ashfaq Ahmed, 'Power Electronics for Technology', Pearson Education, Indian reprint, 2003.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the significance of switching devices and its application to power converters and its characteristics (K2)
- Apply the knowledge of engineering fundamentals to derive the performance parameters of 2 pulse, 3 pulse and 6 pulse converter (K3)
- Apply the knowledge of engineering fundamentals to derive the performance analysis of Buck, Boost, Buck-Boost converters (K3)
- Explain the operation of single phase and three phase Voltage Source Inverters and Current Source Inverters (K2)
- Explain the operation of single & three phase AC Voltage controllers (K2)
- Explain the operation of single & three phase Cyclo converters (K2)

20EE503

DIGITAL SIGNAL PROCESSING

L	T	P	C
3	1	0	4

OBJECTIVES:

To impart knowledge on

Classification of signals and systems & their mathematical representation.

Analysis of discrete-time systems using different types of transforms.

Computation of Discrete Fourier Transform using FFT algorithm.

Design of IIR and FIR digital filters using impulse invariant and bilinear transformation techniques and using various window functions.

Architecture of digital signal processor.

PRE-REQUISITE:

Course Code: 20BS301

Course Name: Transforms and Partial Differential Equations

UNIT – I INTRODUCTION TO SIGNALS AND SYSTEMS**12**

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

UNIT – II DISCRETE TIME SYSTEM ANALYSIS**12**

Z-transform and its properties, ROC - inverse z-transforms-Long division, Partial Fraction Expansion method - difference equation – Solution by Z-transform, Application to discrete systems - Stability analysis, frequency response- Linear Convolution – Analysis of LTI systems in z-domain.

UNIT - III DISCRETE FOURIER TRANSFORM & COMPUTATION**12**

DFT - Properties, magnitude and phase representation - Computation of DFT using FFT algorithm – DIT & DIF - FFT using radix 2 – Butterfly structure – Inverse DFT using FFT algorithm, Circular Convolution.

UNIT - IV DESIGN OF DIGITAL FILTERS**15**

IIR design: IIR filter Realization: Direct Form I and II, Cascade and Parallel forms - Analog filter design - Butterworth and Chebyshev approximations (LPF and HPF) - Digital filter design using Impulse invariant and Bilinear transformation.

FIR design: FIR filter Realization - Linear Phase Characteristics - Filter design using Windowing Techniques (Rectangular, Hamming, Hanning windows only)

UNIT - V DIGITAL SIGNAL PROCESSORS**9**

Introduction – TMS320C5X Architecture DS Processor – Features – Addressing Modes – Functional modes - Introduction to Commercial DS Processors - Application: Musical sound processing system.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. John G. Proakis, D.G. Manolakis and D.Sharma, "Digital Signal Processing Principles, Algorithms and Applications", 4th edition, Pearson Education, 2012.
2. Sanjit K. Mitra, "Digital Signal Processing - A Computer based approach", 4th edition, McGraw-Hill, 2013.

REFERENCES:

1. Alan V Oppenheim, Ronald W Schafer, John R Back, "Discrete Time Signal Processing", 3rd edition, Pearson new international edition, 2014.
2. Emmanuel C. Ifeachor & Barrie W. Jervis - Digital Signal Processing - A practical Approach, 2nd edition, Prentice Hall, 2011.
3. Johny R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 2002.
4. Salivahanan S, A.Vallavaraj, C.Gnanapriya. "Digital Signal Processing", Tata McGraw Hill/TMH, New Delhi, 2014.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Identify the type of given discrete time signals and systems. (K3)
- Apply Z-transform to analyze the given discrete time systems. (K3)
- Apply FFT algorithm to compute DFT. (K3)
- Design IIR filter using impulse invariant and bilinear transformation techniques for the given specifications. (K3)
- Design FIR filter using windowing techniques (Rectangular, Hamming and Hanning) for the given specifications. (K3)
- Explain the architecture of digital signal processors and its addressing modes. (K2)

20EE504

CONTROL SYSTEMS

L	T	P	C
3	1	0	4

OBJECTIVES:

To understand the use of transfer function models to analyze physical systems.

To provide adequate knowledge in the time response of systems and steady state error analysis.

To accord basic knowledge in obtaining the open loop and closed-loop frequency responses of systems.

To introduce stability analysis and design of compensators.

To introduce state variable representation of physical systems.

PRE-REQUISITE:

Course Code: 20EE201, 20BS301

Course Name: Electric Circuit Analysis, Transforms and Partial Differential Equations

UNIT - I SYSTEMS AND REPRESENTATION 12

Concepts of Control Systems – Open and Closed loop systems - Transfer functions – Mathematical modeling - Electrical, Mechanical and Electromechanical systems - Electrical analogues of Mechanical systems – Block diagram - Signal flow graph.

UNIT - II TIME RESPONSE ANALYSIS 12

Standard test signals – Time responses - Time domain specifications – Poles and zeros and their effects on solutions - Steady state error and error constants - Introduction to PI, PD and PID Controllers.

UNIT - III FREQUENCY RESPONSE ANALYSIS 12

Performance specification in frequency domain – Frequency response of standard second order system - Bode plot – Polar plot – Introduction to closed loop Frequency Response - Design of Lag, Lead and Lag-Lead compensator using bode plots.

UNIT - IV CONCEPTS OF STABILITY ANALYSIS 12

The concept of stability – Routh Hurwitz stability criterion – Root Locus Technique: The root locus concept – construction of root loci - Effect of adding poles and zeros – Gain margin and phase margin - Nyquist stability criterion.

UNIT - V STATE VARIABLE ANALYSIS 12

Concepts of State, State variables and State models - State space equations – State space representation of dynamic systems - Transfer function from State Variable Representation - State transition matrix – Concepts of controllability and observability.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Nagarath, I.J. and Gopal, M., 'Control Systems Engineering', New Age International Publishers, 2017.
2. Katsuhiko Ogata, 'Modern Control Engineering', Pearson, 2015.

REFERENCES:

1. Benjamin C. Kuo, 'Automatic Control Systems', Wiley, 2014.
2. Richard C.Dorf and Bishop, R.H., 'Modern Control Systems', Pearson Education, 2009
3. M.Gopal, 'Control System: Principle and design', McGraw Hill Education, 2012
4. Ashfaq Husain, Haroon Ashfaq, 'Control Systems', Dhanpat Rai & Co., 2015

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Apply the knowledge of mathematics, Engineering fundamentals to develop mathematical models for physical system and simplify it using reduction techniques. (K3)
- Apply the knowledge of mathematics, Engineering fundamentals to compute the time domain responses of first and second-order systems to test inputs. (K3)
- Analyze the stability of the system using different frequency domain methods. (K4)
- Design the compensators and their selection to meet desired response. (K4)
- Analyze the behavior of closed loop systems using tools such as Root locus technique, Routh Hurwitz and Nyquist Criteria (K4)
- Apply the knowledge of mathematics, Engineering fundamentals to develop state space models. (K3)

20EE505	MICROPROCESSORS, MICROCONTROLLERS AND APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To understand the Architecture of 8086 microprocessor.

To develop skills in simple program writing in assembly languages

To introduce commonly used peripheral/ interfacing ICs.

To study and understand typical applications of micro-processors.

To study and understand the typical applications of micro-controllers

PRE-REQUISITE:

Course Code: 20EE301.

Course Name: Digital Logic Circuits.

UNIT - I INTRODUCTION TO 8086 MICROPROCESSOR 9

Introduction to 8086 – Microprocessor architecture – Addressing modes - Instruction set and assembler directives – Assembly language programming – Modular Programming - Linking and Relocation - Stacks - Procedures – Macros – Interrupts and interrupt service routines – Byte and String Manipulation.

UNIT - II 8086 SYSTEM BUS STRUCTURE 9

8086 signals – Basic configurations – System bus timing –System design using 8086 – I/O programming – Introduction to Multiprogramming – System Bus Structure – Multiprocessor configurations – Coprocessor, Closely coupled and loosely Coupled configurations – Introduction to advanced processors.

UNIT - III INTERFACING BASICS AND ICS 9

Study of Architecture and programming of ICs: 8255 PPI, 8259 PIC, 8251 USART, 8279 Key board display controller and 8254 Timer/ Counter – Interfacing with 8086 - A/D and D/A converter interfacing.

UNIT - IV INTRODUCTION TO 8051 MICROCONTROLLER 9

Functional block diagram - Instruction format and addressing modes – Interrupt structure – Timer – I/O ports – Serial communication, Simple programming- key board and display interface – Temperature control system - stepper motor control - Usage of integrated development environment (IDE) for assembly language programming

UNIT - V INTRODUCTION TO ADVANCED ARCHITECTURE 9

ARM Cortex-M0 – overview - Programmer’s Model - Memory System Overview - System Control Block - Microcontroller Start sequence - Inputs and Outputs - Development Flow

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Yu-Cheng Liu, Glenn A.Gibson, 'Microcomputer Systems: The 8086 / 8088 Family - Architecture, Programming and Design', Second edition, Pearson, 2015.
2. Muhammad Ali Mazidi & Janice Gilli Mazidi, R.D.Kinely, 'The 8051 Micro Controller and Embedded Systems', PHI Pearson Education, 5th Indian reprint, 2007.
3. Joseph Yiu , 'The Definitive Guide to the ARM Cortex-M0', Newnes – Elsevier, 2011

REFERENCES:

1. B.RAM, 'Computer Fundamentals Architecture and Organization', New age International Private Limited, Fifth edition, 2017.
2. Soumitra Kumar Mandal, 'Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085, 8086, 8051', Mc Graw Hill Edu,2013.
3. Ayala, Kenneth J, 'The 8051 microcontroller : architecture, programming, and applications', Cengage Learning India; 3rd edition, 2007
4. Douglas V.Hall, 'Microprocessor and Interfacing', McGraw Hill Edu, 2016.
5. Krishna Kant, 'Microprocessor and Microcontrollers', Eastern Company Edition, Prentice Hall of India, New Delhi, 2007

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Develop and execute programs in 8086 microprocessor. (K3)
- Explain the System Bus structure of 8086 microprocessor. (K2)
- Illustrate the interfacing of peripheral with microprocessor and microcontroller (K2)
- Explain the architecture and Interrupt structure of 8051. (K2)
- Design microcontroller based Temperature control and stepper motor control system. (K3)
- Explain the architecture of ARM processor. (K3)

20MC501

CONSTITUTION OF INDIA

L	T	P	C
1	0	0	0

OBJECTIVES:

To enable the student to understand the importance of the constitution.

To understand the structure of executive, legislature, and judiciary.

To understand the philosophy of fundamental rights, duties and Emergency Provisions.

To understand the autonomous nature of constitutional bodies like Supreme Court and high court.

To understand the central and state relation financial and administrative.

PRE-REQUISITE: NIL**UNIT-I INTRODUCTION 3**

History of Making of the Indian Constitution - Drafting Committee - (Composition & Working) - Philosophy of the Indian Constitution – Preamble - Salient Features

UNIT-II CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES 3

Fundamental Rights - Right to Equality - Right to Freedom - Right against Exploitation Right to Freedom of Religion - Cultural and Educational Rights - Right to Constitutional Remedies Directive Principles of State Policy - Fundamental Duties

UNIT - III ORGANS OF GOVERNANCE 3

Parliament – Composition - Qualifications and Disqualifications - Powers and Functions -Executive President – Governor - Council of Ministers - Judiciary, Appointment and Transfer of Judges, Qualifications Powers and Functions

UNIT - IV EMERGENCY PROVISIONS 3

Emergency Provisions - National Emergency, President Rule, Financial Emergency

UNIT - V LOCAL ADMINISTRATION 3

District's Administration head- Role and Importance - Municipalities – Introduction - Mayor and role of Elected Representative - CEO of Municipal Corporation - Pachayat raj – Introduction – PRI - Zila Pachayat Elected officials and their roles - CEO Zila Pachayat - Position and role-Block level - Organizational Hierarchy (Different departments) - Village level - Role of Elected and Appointed officials - Importance of grass root democracy

TOTAL: 15 PERIODS**TEXT BOOKS:**

1. Rajesh Kumar, 'Universal's Guide to the Constitution of India', Universal Law Publications, 2016
2. D.C. Gupta, 'Indian Government and Politics', Vikas Pub, 2018.

REFERENCES:

1. H.M.Sreevai, 'Constitutional Law of India', 4th edition in 3 volumes, Universal Law Publication.
2. J.C. Johari, 'Indian Government and Politics', Shoban Lal & Co, 2012.
3. Noorani A.G., (South Asia Human Rights Documentation Centre), 'Challenges to Civil Rights Guarantees in India', Oxford University Press, 2012.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain history and philosophy of Indian Constitution. (K2)
- Explain the premises informing the twin themes of liberty and freedom from a civil rights perspective. (K2)
- Explain the powers and functions of Indian government (K2)
- Explain the emergency rules of Indian Constitution. (K2)
- Explain the structure and functions of local administration. (K2)

20EE5L1	CONTROL AND INSTRUMENTATION LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

To provide knowledge on analysis and design of control system along with basics of instrumentation.

PRE-REQUISITE:

Course Code: 20EE2L2

Course Name: Electric Circuits Laboratory

LIST OF EXPERIMENTS:

CONTROLSYSTEMS:

1. P, PI and PID controllers.
2. Stability Analysis.
3. Modeling of Systems – Machines, Sensors and Transducers.
4. Design of Lag, Lead and Lag-Lead Compensators.
5. Position Control Systems.
6. Synchro - Transmitter-Receiver and Characteristics.
7. Simulation of Control Systems by Mathematical development tools.

INSTRUMENTATION:

8. Bridge Networks – AC and DC Bridges
9. Dynamics of Sensors/Transducers
 - (a) Temperature
 - (b) Pressure
 - (c) Displacement
 - (d) Optical
 - (e) Strain
 - (f) Flow
10. Power and Energy Measurement
11. Signal Conditioning
 - (a) Instrumentation Amplifier
 - (b) Analog –Digital and Digital–Analog converters (ADC and DAC's)

TOTAL: 45 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:		
S.No.	NAME OF THE EQUIPMENT	Qty.
CONTROLSYSTEMS:		
1	PID controller simulation and learner kit	1 No.
2	Digital storage Oscilloscope for capturing transience	1 No.
	Personal Computer with control system simulation packages	10 Nos.
3	Lag and Lead Compensators learner kit	1 No.
4	CRO 30MHz	1 No.
5	2 MHz Function Generator	1 No.
6	Position Control Systems Kit (with manual)	1 No.
	Tacho Generator Coupling set	
7	AC Synchro transmitter & receiver	1 No.
8	Sufficient number of Digital multi meters, speed and torque sensors	
INSTRUMENTATION:		
9	R, L, C Bridge kit (with manual)	1 No.
10	Electric heater	1 No.
	Thermometer	1 No.
	Thermistor (silicon type) RTD nickel type	1 No.
	30 psi Pressure chamber (complete set)	1 No.
	Current generator (0 – 20mA)	1 No.
	Air foot pump (with necessary connecting tubes).	1 No.
	LVDT 20mm core length movability type	1 No.
	CRO 30MHz.	1 No.
	d) Optical sensor, Light source	1 No.
	e) Strain Gauge Kit with Handy lever beam	1 No.
	100gm weights	10 Nos
	f) Flow measurement Trainer kit (1/2 HP Motor, Water tank, Digital Milliammeter, complete set)	1 No.
11	Single phase Auto transformer	1 No.
	Watt-hour meter (energy meter)	1 No.
	Ammeter, Voltmeter, Rheostat, Stop watch, Connecting wires (3/20)	
12	Instrumentation Amplifier kit	1 No.
13	Analog – Digital and Digital –Analog converters (ADC and DACs)	1 No.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Analyze the characteristics of P, PI and PID controllers experimentally and analyze the stability of the control system using MATLAB. (K4)
- Compute the transfer function of a Field controlled DC motor experimentally and analyze the response of Lag, Lead and Lag-Lead Compensators. (K3)
- Analyze the transient response of Position Control system experimentally and analyze the Characteristics of Synchro -Transmitter-Receiver. (K4)
- Use MATLAB for the Simulation of Control Systems. (K3)
- Analyze the basic concepts of bridge networks and to analyze the Dynamics of Sensors/Transducers. (K4)
- Measure the Power and Energy experimentally and analyze signal conditioning circuits. (K4)

20EE5L2	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

To perform simple arithmetic operations using assembly language program and study the addressing modes & instruction set of 8086 & 8051.

To write an assembly language program to convert Analog input to Digital output and Digital input to Analog output.

To perform interfacing experiments with μ P8086.

PRE-REQUISITE:

Course Code: 20EE301.

Course Name: Digital Logic Circuits.

LIST OF EXPERIMENTS:

8086 Programs using kits:

Basic arithmetic and Logical operations.

Move a data block without overlap.

Code conversion, decimal arithmetic and Matrix operations.

Floating point operations, string manipulations, sorting and searching.

Counters and Time Delay.

Peripherals and Interfacing Experiments:

Traffic light controller.

Stepper motor control.

Key board and Display.

Serial interface and Parallel interface.

A/D and D/A interface and Waveform Generation.

8051 Experiments using kits:

11. Basic arithmetic and Logical operations.

12. Square and Cube program, Find 2's complement of a number.

TOTAL: 45 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	NAME OF THE EQUIPMENT	Qty.
1.	8086 Microprocessor Trainer with Power Supply	15 Nos
2.	8051 Micro Controller Trainer Kit with power supply	15 Nos
3.	8255 Interface boards	5 Nos
4.	8251 Interface boards	5 Nos
5.	8259 Interface boards	5 Nos
6.	8279 Keyboard / Display Interface boards	5 Nos
7.	8254 /8253 Interface boards	5 Nos
8.	ADC and DAC cards	5 Nos
9.	Stepper Motor with Controllers	4 Nos
10.	Traffic Light Control Systems	4 Nos

OUTCOMES:**AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:**

- Develop an assembly language program for arithmetic, Logical operations using 8086 processor also Move a data block without overlap. (K3)
- Develop program for code conversion, decimal arithmetic, Matrix operations and Floating point operations. (K3)
- Develop program for Counters and Time Delay and Traffic light controller. (K3)
- Develop programs for serial communication and Stepper motor control (K3)
- Demonstrate the program of Serial interface, Parallel interface, A/D, D/A interface and Waveform Generation (K3)
- Develop an assembly language program for arithmetic, Logical operations, Square and Cube program, Find 2's complement of a number using 8051 microcontroller. (K3)

20HS4L2	PROFESSIONAL COMMUNICATION LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES:

This course is framed for imparting practical approach in learning and enhancing communication skill among engineering students.

Students will be able to identify appropriate expressions in speaking and writing.

Students will also be able to understand this style and perfection of language in reading and listening various contexts of engineering and technology.

The course will benefit to the students to gain confidence for every day communication, technical presentation, aptitude test and interviews.

PRE-REQUISITE:

Course Code: 20HS101

Course Name: English for Technical Communication

UNIT I LISTENING 6

Listen And Take Notes of Lecture, Talks on Engineering and Technology, Developing effective listening skills, Barriers to Effective listening, Listening Self-Introduction Videos.

UNIT II SPEAKING 6

Self-Introduction, Introduce oneself to the audience, Sharing memorable incidents, Individual presentation practice, Introduction to Group Discussion, GD strategies- activities to improve GD skills.

UNIT III READING 6

Reading Online Blogs, Reading Advertisement in Online, Newspaper archives to reading, Reading FAQ's related to job Interview, General awareness of current affairs.

UNIT IV WRITING 6

Process Description, Narrating experience, Creating Email blogs, Review Writing – Books, Movies And Journals, Job Application Letter, Resume Writing.

UNIT V SUMMARIZED ACTIVITIES 6

Reading -cloze exercise, Identifying redundant words, Jargon words, Foreign words, Technical terms Writing- Error free sentence, Essay writing on various levels – basic, middle and advanced, Preparing job application letter and Resume Speaking -Face to face conversation on specific topics, Answering Interview Questions, Panel Interview, Participating in Group Discussion, Technical Presentation.

TOTAL: 30 PERIODS

TEXT BOOKS:

1. E. Suresh Kumar et al. Communication for Professional Success. Orient Black swan: Hyderabad, 2015

REFERENCES:

1. Butterfield, Jeff Soft Skills of Everyone. Cengage Learning: New Delhi, 2015
2. “Interact English Lab Manual for Undergraduate Students”, Orient BlackSwan: Hyderabad, 2016.
3. Raman, Meenakshi and Sangeetha Sharma. Professional Communication. Oxford University Press: Oxford, 2014.
4. S. Hariharanetal. Soft Skills. MJP Publishers: Chennai, 2010.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Express ideas and concepts on par global communication (K3)
- Involve inter-personal communication with flair and error-free verbatim (K3)
- Face interviews confidently and respond in proper language ability (K3)
- Participate in group discussion and share innovative ideas in technical environments (K3)
- Adapt multi-national exposure on employment (K3)
- Master all-round competency in delivering apt communication for employability (K3)

20EE602	POWER SYSTEM OPERATION AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To have an overview of power system operation and control.
- To model power-frequency dynamics and to design power-frequency controller.
- To model reactive power-voltage interaction and the control actions to be implemented for maintaining the voltage profile against varying system load.
- To study the economic operation of power system.
- To discuss about SCADA and its application for real time operation and control of power systems.

PRE-REQUISITE:

Course Code: 20EE501, 20EE402
 Course Name: Power System Analysis, Transmission and Distribution

UNIT-I INTRODUCTION 9

An overview of power system operation and control - system load variation - load characteristics - load curves and load-duration curve - load factor - diversity factor - Importance of load forecasting and quadratic and exponential curve fitting techniques of forecasting – plant level and system level controls.

UNIT-II REAL POWER - FREQUENCY CONTROL 9

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

UNIT-III REACTIVE POWER–VOLTAGE CONTROL 9

Generation and absorption of reactive power - basics of reactive power control - excitation systems – modeling - static and dynamic analysis - stability compensation - methods of voltage control: tap-changing transformer, SVC (TCR + TSC) and STATCOM – secondary voltage control.

UNIT- IV UNIT COMMITMENT AND ECONOMIC DISPATCH 9

Formulation of economic dispatch problem – I/O cost characterization – incremental cost curve – coordination equations without and with loss (No derivation of loss coefficients) - solution by direct method and λ -iteration method - statement of unit commitment problem – priority-list method – forward dynamic programming.

UNIT-V COMPUTER CONTROL OF POWER SYSTEMS 9

Need for computer control of power systems - concept of energy control centre - functions – system monitoring - data acquisition and control - system hardware configuration – SCADA and EMS functions - network topology - state estimation – WLSE - Contingency Analysis - state transition diagram showing various state transitions and control strategies - Recent trends in Contingency Analysis.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Olle.I.Elgerd, 'Electric Energy Systems theory - An introduction', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 34th reprint, 2010.
2. Allen. J. Wood and Bruce F. Wollenberg, 'Power Generation, Operation and Control', John Wiley& Sons, Inc., 2016.

REFERENCES:

1. Abhijit Chakrabarti, Sunita Halder, 'Power System Analysis Operation and Control', PHI learning Pvt. Ltd., New Delhi, Third Edition, 2010.
2. Kundur P., 'Power System Stability and Control', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 10th reprint, 2010.
3. N.V.Ramana, 'Power System Operation and Control', Pearson, 2011.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Apply electrical engineering knowledge to calculate the values of load distribution parameters. (K3)
- Analyze the modeling for two area control system with and without controller (K4)
- Explain various types of excitation system and derive the modeling of AVR (K2)
- Solve the Unit Commitment problems using priority method (K3)
- Solve the Economic Dispatch problems (K3)
- Explain the data acquisition and control in power systems and to analyze the contingency of power system (K3)

20IT301	OBJECT ORIENTED PROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

PRE-REQUISITE:

Course code : 20CS201

Course Name : Programming in C

UNIT-I INTRODUCTION TO OOP AND JAVA FUNDAMENTALS 9

Introduction to Object Oriented Programming –Differences between Structure programming and OOPS-Characteristics of Java – The Java Environment -Java Source File -Structure – Compilation. Fundamental Programming Structures in Java – Defining classes in Java – constructors, methods -access specifiers - static members -Comments, Data Types, Variables, Operators, Control Flow, Arrays , Packages - JavaDoc comments, finalize method, Automatic Garbage Collection.

UNIT-II INHERITANCE AND INTERFACES 9

Inheritance – the Object class – abstract classes and methods- final methods and classes – Interfaces –differences between classes and interfaces and extending interfaces - Object cloning, Reflection, Proxies -inner classes, Array Lists - Strings

UNIT-III EXCEPTION HANDLING AND I/O 9

Exceptions - exception hierarchy - throwing and catching exceptions – built-in exceptions, creating own exceptions, Assertions, logging, Stack Trace Elements. Input / Output Basics – Streams – Byte streams and Character streams – Reading and Writing Console – Reading and Writing Files- Sequential Access file and Random Access file.

UNIT-IV MULTITHREADING AND GENERIC PROGRAMMING 9

Differences between multi-threading and multitasking, thread life cycle, creating threads, synchronizing threads, Inter-thread communication, daemon threads, thread groups. Generic Programming – Generic classes – generic methods – Inheritance & Generics – Reflection & Generics-Bounded Types – Restrictions and Limitations.

UNIT-V EVENT DRIVEN PROGRAMMING 9

Graphics programming - Frame – Components - working with 2D shapes - Using color, fonts, and images - Basics of event handling - event handlers - adapter classes - actions - mouse events - AWT event hierarchy - Introduction to Swing – layout management - Swing Components – Text Fields , Text Areas – Buttons- Check Boxes – Radio Buttons – Lists- choices- Scrollbars – Windows –Menus – Dialog Boxes- Case Study: Design an application for automating the file processing by using the java swing with mysql database.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Herbert Schildt, "Java The complete reference", 9th Edition, McGraw Hill Education, 2017.
2. Cay S. Horstmann, Gary cornell, "Core Java Volume –I Fundamentals", 9th Edition, Prentice Hall, 2013.
3. E. Balagurusamy, "Programming with Java", 6th Edition, McGraw Hill Education, 2019.

REFERENCES:

1. Paul Deitel, Harvey Deitel, "Java SE 8 for programmers", 3rd Edition, Pearson, 2015.
2. Steven Holzner, "Java 2 Black book", Dreamtech press, 2011.
3. Timothy Budd, "Understanding Object-oriented programming with Java", Updated Edition, Pearson Education, 2000.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Realize the Object-Oriented Programming concepts and Basics of java Programming tool. (K3)
- Apply the concepts of inheritance and interfaces using java programs (K3)
- Construct java exceptions and I/O streams (K3)
- Illustrate multithread concepts and generics in java (K3)
- Design and develop interactive java application using AWT (K3)
- Design and develop interactive java application using Swing (K3)

20EE6L1

**POWER ELECTRONICS AND DRIVES
LABORATORY**

L	T	P	C
0	0	3	1.5

OBJECTIVES:

- To examine the characteristics of various power electronics devices.
- To outline the performance characteristics of Converter, chopper, AC voltage controller, inverter and Switched mode power converter.
- To gain practical experience on converter, chopper fed dc motor drives.
- To gain practical experience on Inverter fed induction motor drives.
- To simulate the basic topological power converter circuits.

PRE-REQUISITE:

Course Code: 20EE3L1

Course Name: Electronics Laboratory

LIST OF EXPERIMENTS:

1. Characteristics of SCR and Gate Pulse Generation of R, RC and UJT.
2. Characteristics of TRIAC and IGCT.
3. Characteristics of MOSFET and IGBT.
4. Single phase AC to DC Semi converter / Simulation of semi converters.
5. Single phase AC to DC fully controlled Converter / Simulation of full converters.
6. Step down and step up MOSFET based choppers / Simulation of DC-DC converters.
7. Single phase AC Voltage controller / Simulation of AC voltage controllers.
8. Switched mode power converter.
9. IGBT based Single phase PWM inverter.
10. IGBT based Speed control of three phase PWM inverter fed Induction motor.
11. Micro controller based speed control of Converter and Chopper fed DC motor.

TOTAL: 45 PERIODS**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:**

S.No.	NAME OF THE EQUIPMENT	Qty.
1.	Device characteristics(for SCR, MOSFET, TRIAC, IGCT and IGBT kit with built-in / discrete power supply and meters)	2 Nos. each
2.	Single phase SCR based half controlled converter and fully controlled converter along with built-in / separate / firing circuit / module and meter	2 Nos. each
3.	MOSFET based step up and step down choppers (Built in / Discrete)	1 No.
4.	IGBT based single phase PWM inverter module / Discrete Component	2 Nos.
5.	IGBT based three phase PWM inverter module / Discrete Component	2 Nos.
6.	Switched mode power converter module / Discrete Component	2 Nos.
7.	SCR & TRIAC based 1 phase AC controller along with lamp or rheostat load	2 Nos.
8.	Digital Storage Oscilloscope	5 Nos.
9.	Cathode ray Oscilloscope	5 Nos.
10.	Multimeter	5 Nos.
11.	Work table	10 Nos.
12.	DC and AC meters of required ranges	10 value

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Conduct on experiment to generate the gate pulse of SCR using R, RC and UJT triggering circuit and differentiate the VI characteristics of power electronics devices. (K3)
- Conduct on experiment to analyze the performance of the designed single phase AC to DC semi converter and fully controlled converter with R and RL load using MATLAB simulation tool. (K4)
- Conduct on experiment to analyze the performance of the designed step down and step up MOSFET based choppers using MATLAB simulation tool. (K4)
- Conduct on experiment to analyze the performance of the designed AC –AC converters and Switched mode power converter using MATLAB simulation tool. (K4)
- Conduct on experiment to show the frequency response of single phase PWM inverter and inverter fed induction motor drive. (K3)
- Demonstrate the speed control of the given Micro controller based DC drive by conducting suitable experiment. (K3)

20EE6L2	MINI PROJECT-I	L	T	P	C
		0	0	4	2

OBJECTIVES:

To develop the students own innovative prototype ideas.

To train the students in preparing mini project reports and examination.

PRE-REQUISITE: NIL

The students in a group of 2 to 4 works on a topic approved by the head of the department and prepare a comprehensive mini project report after completing the work to the satisfaction. The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A mini project report is required at the end of the semester. The mini project work is evaluated based on oral presentation and the mini project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 60 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

On Completion of the mini project work students will be in a position to take up their Final year project work and find solution by formulating proper methodology.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Identify and apply the real world and societal importance problems in the Electrical and its allied area. (K4)
- Identify, analyze, design, implement and handle prototype projects with a complete and organized solution methodologies (K4)
- Apply modern engineering tools for solution (K4)
- Contribute as an individual or in a team in development of technical projects (K4)
- Develop effective communication skills for presentation of project related activities (K4)
- Prepare reports and examination following professional ethics (K4)

20CS6L3	OBJECT ORIENTED AND JAVA PROGRAMMING LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

To build software development skills using java programming for real-world applications.

To understand and apply the concepts of classes, packages, interfaces, array list, exception handling and file processing.

To develop applications using generic programming and event handling.

PRE-REQUISITE:

Course code : 20CS201

Course Name : Programming in C

LIST OF EXPERIMENTS:

1. a) Write a Java program that checks whether a given string is a palindrome or not.

b) Write a Java program for sorting list of names. Read input from command line

Develop a Java application to generate Electricity bill. Create a class with the following members: Consumer no., consumer name, previous month reading, current month reading, type of EB connection (i.e domestic or commercial). Compute the bill amount using the following tariff.

If the type of the EB connection is domestic, calculate the amount to be paid as follows:

First 100 units	Rs. 1.00 per unit
101-200 units	Rs. 2.50 per unit
201 -500 units	Rs. 4.00 per unit
> 501 units	Rs. 6.00 per unit

If the type of the EB connection is commercial, calculate the amount to be paid as follows:

First 100 units	Rs. 2.00 per unit
101-200 units	Rs. 4.50 per unit
201 -500 units	Rs. 6.00 per unit
> 501 units	Rs. 7.00 per unit

Develop a java application to implement currency converter (Dollar to INR, EURO to INR, Yen to INR and vice versa), distance converter (meter to KM, miles to KM and vice versa), time converter (hours to minutes, seconds and vice versa) using packages.

Develop a java application with Employee class with Emp_name, Emp_id, Address, Mail_id, Mobile_no as members. Inherit the classes, Programmer, Assistant Professor, Associate Professor and Professor from employee class. Add Basic Pay (BP) as the member of all the inherited classes with 97% of BP as DA, 10 % of BP as HRA, 12% of BP as PF, 0.1% of BP for staff club fund. Generate pay slips for the employees with their gross and net salary.

Design a Java interface for ADT Stack. Implement this interface using array. Provide necessary exception handling in both the implementations.

Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named print Area(). Provide three classes named Rectangle, Triangle and Circle such that each one of the classes extends the class Shape. Each one of the classes contains only the method print Area () that prints the area of the given shape.

Write a Java program to implement user defined exception handling.

Write a Java program that reads a file name from the user, displays information about whether the file exists, whether the file is readable, or writable, the type of file and the length of the file in bytes.

Write a java program that implements a multi-threaded application that has three threads. First thread generates a random integer every 1 second and if the value is even, second thread computes the square of the number and prints. If the value is odd, the third thread will print the value of cube of the number.

Write a java program to find the maximum value from the given type of elements using a generic function.

TOTAL: 45 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

Software Requirement :

JDK8.0 / Net beans 11

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Develop and implement Java programs for simple applications that make use of classes, packages. (K3)
- Develop and implement Java programs with inheritance and interfaces. (K3)
- Develop Java programs to implement function polymorphism. (K3)
- Develop simple java programs with use of files and exceptions. (K3)
- Develop simple java programs by implementing multithread concepts. (K3)
- Develop simple java program by using generic concepts. (K3)

20EE701	PROTECTION AND SWITCH GEAR	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart knowledge on the following

- Causes of abnormal operating conditions (faults, lightning and switching surges) of the apparatus and system.
- Characteristics and functions of relays and protection schemes.
- Apparatus protection, static and numerical relays
- Functioning of circuit breaker

PRE-REQUISITE:

Course Code: 20EE501

Course Name: Power System Analysis

UNIT - I OVERVOLTAGE PROTECTION 9

Causes and Effects of Over Voltages - Switching and lightning over voltages – Lightning Mechanism – Lightning Arresters and surge diverters

UNIT - II ELECTROMAGNETIC RELAYS 9

Zones of protection and essential qualities of protection- Operating principles of relays - the Universal relay – Torque equation – R-X diagram – Electromagnetic Relays – Over current, Directional, Distance, Differential, Negative sequence and Under frequency relays.

UNIT - III APPARATUS PROTECTION 9

Current transformers and Potential transformers applications in protection schemes -Protection of transformer, generator, motor, bus bars and transmission line.

UNIT - IV NUMERICAL PROTECTION 9

Block diagram of Numerical relays – Over current protection, transformer differential protection, distance protection of transmission lines – Microcontroller Assembly language programming for over current, directional and distance protection.

UNIT - V CIRCUIT BREAKERS 9

Physics of arcing phenomenon and arc interruption - DC and AC circuit breaking – re-striking voltage and recovery voltage - rate of rise of recovery voltage - resistance switching - current chopping - interruption of capacitive current - Types of circuit breakers – air blast, air break, oil, SF6, MCBs, MCCBs and vacuum circuit breakers – comparison of different circuit breakers – Rating and selection of Circuit breakers.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Badri Ram, B.H. Vishwakarma, 'Power System Protection and Switchgear', New Age International (P) Ltd, 2nd Edition, 2017.
2. B.Rabindranath and N.Chander, 'Power System Protection and Switchgear', New Age International (P) Ltd., First Edition 2018.
3. Y.G.Paithankar and S.R.Bhide, 'Fundamentals of power system protection', 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2010.

REFERENCES:

1. Sunil S.Rao, 'Switchgear and Protection', Shree Hari Publications, New Delhi, 2021.
2. ArunIngole, 'Switch Gear and Protection' Pearson Education, 2018.
3. Ravindra P.Singh, 'Switchgear and Power System Protection', PHI Learning Private Ltd., New Delhi, 2009.
4. VK Metha, "Principles of Power Systems" S. Chand, 2005.
5. A. Chakrabarti, M.L. Soni, P.V. Gupta, U.S. Bhatnagar, "A textbook on Power system Engineering" Dhanpat Rai Publishing Company (P) Ltd.2008
6. C.L.Wadhwa, "Electrical Power Systems", New Age International Private Limited, 2022

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the Over voltage Protection of Power Systems (K2)
- Explain the characteristics and functions of Electromagnetic typeprotective relays (K2)
- Describe the various abnormal conditions in power system apparatusand to select a suitable protection scheme (K2)
- Develop assembly language programming for numerical over current,directional and distance protection (K3)
- Analyze the circuit interruption problems (K4)
- Explain the operation of Air, Oil, SF6 and Vacuum Circuit Breakers (K2)

20EE702	RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart knowledge on the following Topics

- Awareness about renewable Energy Sources and technologies.
- Adequate inputs on a variety of issues in harnessing renewable Energy.
- Recognize current and possible future role of renewable energy sources.
- Provide adequate inputs on Hybrid Renewable Energy Systems
- Provide adequate inputs on Intelligent Controllers for Hybrid Systems.

PRE-REQUISITE:

Course Code: 20EE201, 20EE402

Course Name: Electric Circuit Analysis, Transmission and Distribution

UNIT - I RENEWABLE ENERGY (RE) SOURCES 9

Environmental consequences of fossil fuel use, Importance of renewable sources of energy, Sustainable Design and development, Types of RE sources, Limitations of RE sources, Present Indian and international energy scenario of conventional and RE sources.

UNIT - II SOLAR AND PV SYSTEMS 9

Solar Radiation, Radiation Measurement, Central Receiver Power Plants, Solar Ponds.- Solar Photovoltaic systems : Basic Principle of SPV conversion – Types of PV Systems - Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array, PV Module I-V Characteristics, Efficiency & Quality of the Cell, series and parallel connections, maximum power point tracking, Applications.

UNIT - III WIND ENERGY 9

Power in the Wind -Basic principles of Wind Energy Conversion Systems (WECS), Types and Classification of WECS, Parts of WECS, Power, torque and speed characteristics, Stand alone and grid connected of WECS, Grid integration issues of WECS, Site selection criteria.

UNIT - IV BIOMASS AND HYDRO ENERGY SOURCES 9

Introduction-Bio mass resources –Energy from Bio mass: conversion processes-Biomass Cogeneration- Biomass Gasification, Biomass to Ethanol Production, Biogas production from waste biomass, Environmental Benefits. Mini/micro hydro power: Classification of hydropower schemes, Classification of water turbine, Turbine theory, Essential components of hydroelectric system.

UNIT - V GEOTHERMAL , OCEAN AND OTHER ENERGY SOURCES 9

Geothermal Energy: Basics, Direct Use, Geothermal Electricity. Tidal Energy: Energy from the tides, Barrage and Non Barrage Tidal power systems. Wave Energy: Energy from waves, wave power devices. Ocean Thermal Energy Conversion (OTEC). Hydrogen Production and Storage- Fuel cell: Principle of working- various types - construction and applications. Energy Storage System- Hybrid Energy Systems.

TOTAL: 45PERIODS

TEXT BOOKS:

1. Joshua Earnest, Tore Wizeliu, 'Wind Power Plants and Project Development', PHI Learning Pvt.Ltd, New Delhi, 2011
2. D.P.Kothari, K.C Singal, Rakesh Ranjan "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt. Ltd, New Delhi, 2013
3. Rai G.D. , Non-Conventional Energy Sources, Khanna Publishers, 2011

REFERENCES:

1. Chetan Singh Solanki, " Solar Photovoltaics : Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2011
2. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.
3. Shobh Nath Singh, 'Non-conventional Energy resources' Pearson Education, 2015

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Describe about renewable Energy Sources and technologies. Outline the Environmental consequences of fossil fuel use (K2)
- Discuss the basic principle and types of solar PV system and thermal energy systems (K2)
- Explain the basic principles, types and Grid integration issues of Wind Energy Conversion Systems (K2)
- Summarize the electrical power from bio-mass energy and Hydro energy (K2)
- Describe the electrical power from geothermal energy, Ocean energy, Hydrogen energy and Fuel cell. (K2)
- Explain the different types of Hybrid energy systems with their advantages and disadvantages (K2)

20EE7L1	POWER SYSTEM SIMULATION LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

To provide better understanding of power system parameter and Power System Analysis using software languages and MATLAB/Simulink.

PRE-REQUISITE: NIL

LIST OF EXPERIMENTS:

1. Modelling of Transmission line
2. Formation of bus admittance matrix.
3. Power flow analysis by Gauss-Seidel method.
4. Power flow analysis using Newton-Raphson method.
5. Short circuit analysis of Transmission line.
6. Stability analysis of Power system: Single Machine Infinite Bus System
7. Economic Dispatch in Power Systems.
8. Load – Frequency Dynamics of Single- Area and Two-Area Power Systems
9. Electromagnetic Transients in Power Systems: Transmission Line Energization
10. Transient Stability Analysis of Multi machine Power Systems

TOTAL: 45 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	NAME OF THE EQUIPMENT	Qty.
1.	Personal computers (Intel i3, 80GB, 2GBRAM)	30 Nos.
2.	Printer laser	1 No.
3.	Dot matrix	1 No.
4.	Server (Intel i5, 80GB, 2GBRAM) (High Speed Processor)	1 No
5.	Software: any power system simulation software with 5 user licenses	.
6.	Compilers: C, C++, VB, VC++	30 Users.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Develop coding to determine the various line parameters of a transmission line. (K3)
- Develop coding to form bus admittance matrix for the given powersystem network. (K3)
- Develop program to determine the line losses of the given powersystem network. (K3)
- Develop simulink model for fault analysis in the transmission line using bus impedance matrix. (K3)
- Develop the coding to solve the economic dispatch problem in Power system. (K3)
- Analyze the steady state and Transient stability of the given powersystem using simulation (K3)

20EE7L2	RENEWABLE ENERGY SYSTEMS LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

- To train the students in Renewable Energy Sources and technologies.
- To provide adequate inputs on a variety of issues in harnessing Renewable Energy.
- To recognize current and possible future role of Renewable energy sources.
- To provide adequate inputs on Hybrid Renewable Energy Systems
- To provide adequate inputs on Intelligent Controllers for Hybrid Systems.

RE-REQUISITE:

Course Code: 20EE3L1, 20EE6L1

Course Name: Electronics Laboratory, Power Electronics and Drives Laboratory

LIST OF EXPERIMENTS:

1. Simulation study on Solar PV Energy System.
2. Experiment on “VI-Characteristics and Efficiency of 1kWp Solar PV System”
3. Experiment on “Shadowing effect & diode based solution in 1kWp Solar PV System”.
4. Experiment on Performance assessment of Grid connected and Standalone 1kWp Solar Power System
5. Simulation study on Wind Energy Generator
6. Experiment on Performance assessment of micro Wind Energy Generator
7. Simulation study on Hybrid (Solar-Wind) Power System.
8. Experiment on Performance Assessment of Hybrid (Solar-Wind) Power System.
9. Simulation study on Hydel Power.
10. Simulation study on Intelligent Controllers for Hybrid Systems.

TOTAL: 45 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	NAME OF THE EQUIPMENT	Qty.
1.	Personal computers (Intel i3, 80GB, 2GBRAM)	15 Nos.
2.	CRO(30MHz)	9 Nos.
3.	Digital Multi-meter	10 Nos.
4.	PV panels - 100W, 24V	1 No.
5.	Battery storage system with charge and discharge control 40Ah	1 No.
6.	PV Emulator	1 No.
7.	Micro Wind Energy Generator module	1 No.
Consumables (Minimum of 5 Nos. each)		
8.	Potentiometer	5 Nos.
9.	Step-down transformer (230V/12-0-12V)	5 Nos.
10.	Component data sheets to be provided	

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Analyze VI-Characteristics and Efficiency of 1kWp Solar PV System (K4)
- Analyze the Shadowing effect & diode based solution in 1kWp SolarPV System (K4)
- Analyze the Performance of Grid connected and Standalone 1kWpSolar Power System. (K4)
- Simulate the various Renewable energy sources (K3)
- Analyze the performance characteristics of micro Wind EnergyGenerator (K4)
- Analyze the performance characteristics of Hybrid (Solar-Wind)Power System. (K4)

20EE7L3**MINI PROJECT-II**

L	T	P	C
0	0	6	3

OBJECTIVES:

- To develop the students own innovative prototype ideas.
- To train the students in preparing mini project reports and examination.

PRE-REQUISITE: NIL

The students in a group of 2 to 4 works on a topic approved by the head of the department and prepare a comprehensive mini project report after completing the work to the satisfaction. The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A mini project report is required at the end of the semester. The mini project work is evaluated based on oral presentation and the mini project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 90 PERIODS**OUTCOMES:****AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:**

On Completion of the mini project work students will be in a position to take up their Finalyear project work and find solution by formulating proper methodology.

OUTCOMES:**AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:**

- Identify and apply the real world and societal importance problems inthe Electrical and its allied area. (K4)
- Identify, analyze, design, implement and handle prototype projects witha complete and organized solution methodologies (K4)
- Apply modern engineering tools for solution (K4)
- Contribute as an individual or in a team in development of technicalprojects (K4)
- Develop effective communication skills for presentation of projectrelated activities (K4)
- Prepare reports and examination following professional ethics (K4)

20EE8L1

PROJECT WORK

L	T	P	C
0	0	20	10

OBJECTIVES:

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.
- 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.
- 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.
- 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.

OUTCOMES:

- 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.

TOTAL: 300 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Identify and apply the real world and societal importance problems in the Electrical and its allied area. (K4)
- Identify, analyze, design, implement and handle prototype projects with a complete and organized solution methodologies (K4)
- Apply modern engineering tools for solution (K4)
- Contribute as an individual or in a team in development of technical projects (K4)
- Develop effective communication skills for presentation of project related activities (K4)
- Prepare reports and examination following professional ethics (K4)

20EEV11	PROFESSIONAL ELECTIVE – I POWER QUALITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the various power quality issues.
- To understand the causes, impacts and mitigation of Voltage sag and interruptions in power system.
- To understand the causes, impacts and mitigation of over voltages in power system with PSCAD and EMTP.
- To understand the concept of harmonics in power system with their causes, effects and control techniques.
- To understand the various types of conventional and modern power quality monitoring devices/methods.

PRE-REQUISITE: NIL

UNIT - I INTRODUCTION 9

Terms and definitions – Overloading – Under voltage – Sustained interruption - Sags and Swells – Waveform distortion – Total Harmonic Distortion (THD) – Computer Business Equipment Manufacturers Associations (CBEMA) curve.

UNIT - II VOLTAGE SAGS AND INTERRUPTIONS 9

Sources of sags and interruptions – Estimating voltage sag performance – Motor starting sags – Estimating the sag severity – Mitigation of voltage sags – Active series compensators – Static transfer switches and fast transfer switches.

UNIT - III OVERVOLTAGES 9

Sources of over voltages – Capacitor switching – Lightning – Ferro resonance – Mitigation of voltage swells – Surge arresters – Low pass filters – Power conditioners – Lightning protection – Shielding – Line arresters – Protection of transformers and cables – Computer analysis tools for transients – PSCAD and EMTP.

UNIT - IV HARMONICS 9

Harmonic distortion – Voltage and current distortion – Harmonic indices – Harmonic sources from commercial and industrial loads – Locating harmonic sources – Power system response characteristics – Resonance – Harmonic distortion evaluation – Devices for controlling harmonic distortion – Passive filters – Active filters – IEEE and IEC standards.

UNIT - V POWER QUALITY MONITORING AND CUSTOM POWER DEVICES 9

Power line disturbance analyzer - Harmonic/Spectrum analyzer - Flicker meters - Rectifier supported DVR – DC Capacitor supported DVR – DVR Structure – voltage Restoration – Series Active Filter – Unified power quality conditioner.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. R.C. Duggan , “Power Quality”, McGraw-Hill Education, 2012.(2nd edition)
2. A.J. Arrillga, “Power system harmonics”, Wiley, 2003 (2nd edition)

REFERENCES:

1. G.T.Heydt, “Electric Power Quality”, Stars in a Circle Publications, 1994 (2nd edition)
2. Derek A. Paice, “Power Electronic Converter Harmonics”, Wiley-IEEE Press-1st Edition-1999

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain power quality disturbances, their causes, detrimental effects and Power quality standard. (K3)
- Describe the impact of voltage sag and interruptions in power systems. (K3)
- Analyze the over voltage phenomena using PSCAD and EMTP. (K4)
- Describe the impact of Harmonics in power systems. (K3)
- Explain the different types of monitoring devices/methods for power quality in power system. (K3)
- Discuss the different types of custom power devices for enhancement of power quality in power system. (K3)

20EEV12

MODERN POWER CONVERTERS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge on the Switched mode power supplies.
- To understand the performance analysis and operation of the AC to DC converter and DC to AC converter.
- To study the concept of Matrix Converter.
- To introduce the Soft switched converters.
- To impart knowledge on the Switched mode power supplies.

PRE-REQUISITE: NIL

UNIT - I SWITCHED MODE POWER SUPPLIES (SMPS) 9

DC Power supplies and Classification - Switched mode dc power supplies - with and without isolation - single and multiple outputs - Closed loop control and regulation - Design examples on converter and closed loop performance.

UNIT - II AC-DC CONVERTERS 9

Switched mode AC-DC converters - Synchronous rectification - single and three phase topologies - switching techniques - high input power factor - Reduced input current harmonic distortion - Improved efficiency - with and without input-output isolation - Performance indices design examples.

UNIT - III DC-AC CONVERTERS 9

Multi-level Inversion – concept - classification of multilevel inverters - Principle of operation - main features and analysis of Diode clamped - Flying capacitor and cascaded multilevel inverters - Modulation schemes.

UNIT - IV AC-AC CONVERTERS WITH AND WITHOUT DC LINK 9

Matrix converters - Basic topology of matrix converter - Commutation – current path - Modulation techniques - scalar modulation - indirect modulation - Matrix converter as only AC-DC converter - AC-AC converter with DC link - topologies and operation - with and without resonance link - converter with dc link converter - Performance comparison with matrix converter with DC link converters.

UNIT - V SOFT-SWITCHING POWER CONVERTERS 9

Soft switching techniques – ZVS – ZCS - quasi resonance operation - Performance comparison hard switched and soft switched converters - AC-DC converter - DC-DC converter - DC-AC converter - Resonant DC power supplies.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Ned Mohan, T.M Undeland and W.P Robbin, "Power Electronics: converters, Application and design" John Wiley and sons. Wiley India edition, 2006.
2. M.H.Rashid, 'Power Electronics Handbook', Academic press, New York, 2001.
3. Fang Lin Luo and Hang Ye, 'Advanced DC/DC Converters', CRC Press, 2017.

REFERENCES:

1. Issa Batarseh, 'Power Electronic Circuits', John Wiley and Sons, Inc.2004.
2. Marian P.Kazmierkowski, R.Krishnan and Frede Blaabjerg, 'Control in Power Electronics- Selected Problem', Academic Press (Elsevier Science), 2002.
3. Frede Blaabjerg and Zhe Chen, 'Power Electronics for Modern Wind Turbines', Morgan and Claypool Publishers series, United States of America, 2006.
4. Krein Philip T, 'Elements of Power Electronics', Oxford University press, 2008.
5. Agarwal, 'Power Electronics: Converters, Applications, and Design', 3rd edition, Jai P,Prentice Hall, 2000.
6. L. Umanand, 'Power Electronics: Essentials & Applications', John Wiley and Sons, 2009.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the concepts and working of Switched mode dc power supplies. (K3)
- Explain the various AC-DC power converter circuits and their switching techniques. (K3)
- Analyze various types of DC-AC power converter circuits. (K4)
- Design various basic topology of Matrix converter. (K3)
- Compare AC-AC Power converter performance with and without dc link. (K3)
- Describe the operating principle of soft switching power converter and compare various types of Soft Switched Power converters. (K3)

20EEV13	POWER ELECTRONIC CONVERTERS FOR ELECTRIC VEHICLE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the concept of Power electronic devices
- To study the operation, switching techniques and basics topologies of DC-DC Converter.
- To understand the operation of Controlled rectifiers and Inverters that can be used in electric vehicles
- To understand the operation of Power electronic based drives that can be used in electric vehicles
- To understand the control of hybrid and fuel cell vehicles
- To understand the concept of Power electronic devices

PRE-REQUISITE:

Course Code: 20EE302, 20EE304

Course Name: Electron Devices and Circuits, Electrical Machines – I

UNIT - I BASIC POWER ELECTRONIC DEVICES 9

Diodes – Thyristors - Bipolar Junction Transistors – Metal Oxide Semiconductor Field Effect Transistors - Insulated Gate Bipolar Transistors - Ultra capacitors.

UNIT - II DC/DC CONVERTER 9

Basic Principle of DC–DC Converter - Step-Down (Buck) Converter - Step-Up (Boost) Converter - Buck–Boost Converter - DC–DC Converters Applied in Hybrid Vehicle Systems - Isolated Buck DC–DC Converter - Four-Quadrant DC–DC Converter.

UNIT - III RECTIFIERS AND INVERTERS 9

Single-phase Diode Rectifiers - Three-phase Diode Rectifiers - Poly-phase Diode Rectifiers - Filtering Systems in Rectifier Circuits - High-frequency Diode Rectifier Circuits - Single-phase Voltage Source Inverters - Three-phase Voltage Source Inverters - Current Source Inverters - Closed-loop Operation of Inverters - Regeneration in Inverters - Multistage Inverters.

UNIT - IV ELECTRIC MOTOR DRIVES 9

DC motor speed control and braking - Chopper control based ac motor drives - cyclo-converter fed ac motor drives - slip power recovery scheme - four quadrant operation of electric drives.

UNIT - V CONTROL OF HYBRID AND FUEL CELL VEHICLES 9

Fuel Cell Vehicles - Power Electronics Requirements - Propulsion Motor Control Strategies - APU Control System in Series Hybrid Vehicles - Fuel Cell for APU Applications.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Mehrdad Ehsani, Yimin Gao, Stefano Longo, Kambiz Ebrahimi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles”, CRC Press, Third Edition, 2019
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, Taylor & Francis Group, Third Edition 2021.

REFERENCES:

1. “Power Electronics”, P.S.Bimbhra, Khanna publications, 2020.
2. “Thyristorised Power Controllers”, G.K.Dubey, New Age international publishers, 2019.
3. “Power Electronic Converters Modeling and Control: with Case Studies”, Seddik basha, Springer, 2018.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the basics of various power electronics devices suitable for electric vehicles. (K2)
- Explain the operation of DC-DC Converters used in electric vehicles (K2)
- Explain the operation of rectifiers and inverters used in electric vehicles (K2)
- Explain the various DC motor drives suitable for EV (K2)
- Explain the various AC motor drives suitable for EV (K2)
- Explain the Electric Propulsion unit of Electric vehicles (K2)

20EEV14

EMBEDDED PROCESSORS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To provide the students with basic knowledge of Arduino microcontroller and types of signals.
- To Train the students in the basics of different types of basic sensors and their practical usage.
- To train the students on optimal selection of components based on the application.
- To provide the students with hands on experience on handling of microcontrollers and other components to provide them an edge in fast moving industry.

PRE-REQUISITE:

Course Code: 20EE301.

Course Name: Digital Logic Circuits.

UNIT - I Introduction to Embedded Systems

9

Understanding embedded system - Overview of basic electronics and digital electronics - Microcontroller & microprocessor - Comparison between the two microcontroller (vs) microprocessor - Common features of microcontroller - Different types of microcontroller.

Introduction to Arduino - Pin configuration and architecture - Device and platform features
Concept of digital and analog ports - Familiarizing with Arduino Interfacing Board Introduction to Embedded C and Arduino platform

UNIT - II Review of Basic Concepts of Arduino

9

Arduino data types - Variables and constants – Operators - Control Statements – Arrays – Functions - Pins Configured as input - Pull-up Resistors - Pins Configured as output-pin Mode () Function-digital Write () Function - analog Read() function – Arduino Interrupts – Arduino Time - delay () function - millis () function - micros () function

UNIT - III Arduino Displays and Sensors

9

Working with Serial Monitor - Line graph via serial monitor - Interfacing a 8 bit LCD to Arduino Fixed one line static message display - Running message display-Using the LCD Library of Arduino - HC-SR04 Ultrasonic Module - IR Infrared Obstacle Avoidance sensor - Soil Moisture Sensor - Photo resistor sensor - Digital thermal sensor – Temperature sensor - Rotary Encoder Module - MQ-2 Gas sensor - SW-420 Motion sensor - Humidity and Rain Detection sensor - IR Infrared Flame Detection sensor - 5V/12V-Relay module (2 channel to 16 channel) - DHT11 Temperature and Humidity sensor

UNIT - IV Arduino Secondary Integrations

9

Types of Relays -Controlling Electrical appliances with electromagnetic relays -Working of a matrix keypad - Using the keypad library to interface with Arduino - Interfacing Servo motors to Arduino -Interfacing a RF Module - Giving Input to the controller - Using serial input - Controlling LEDs with keys - Keys as toggle switch - Interfacing a piezo buzzer - Using a buzzer as an alarm unit

UNIT - V Arduino Communications, IOT and Cloud Computing

9

Serial /Parallel Communication - Types of Serial Communications - Arduino UART - GSM/GPRS Arduino Interfacing - IOT and Cloud Computing - Understanding IoT fundamentals - IOT Architecture and protocols - Overview of IoT - components and IoT Communication Technologies - Basics of Wireless Networking - Introduction to ESP8266 Wi-Fi Module - Various Wi-Fi library -Web server - Introduction, installation, configuration - Posting sensor(s) data to web server - Virtualization concepts and Cloud Architecture - Cloud computing, benefits - Cloud services - SaaS, PaaS, IaaS - Cloud providers & offerings -Study of IOT Cloud platforms – Thing Speak API and MQTT - Interfacing ESP8266 with Web services - Making it a reality - Arduino Projects

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Embedded System-Architecture, Programming, Design, Rajkamal, McGraw Hill, 2013
2. Embedded system Design, Peckol, John Wiley & Sons, 2010

REFERENCES:

1. Introduction to Embedded Systems, Shibu. K.V, Tata Mcgraw Hill,2009
2. Real-Time systems Theory and Practice, Rajib Mall, Pearson Education, 2007
3. Embedded system Design Using C8051, Han-Way Huang, Cengage Learning, 2009

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Understand the basics of Embedded processors and Arduino development kits (K2)
- Understand the programming concepts of Arduino development kits (K2)
- Understand the interfacing of display units in Arduino development boards (K2)
- Understand the interfacing of sensors in Arduino development boards (K2)
- Understand the interfacing of relays and motors in Arduino development boards
- Understand the interfacing of IoT applications in clouds by using Arduino development boards (K2)

20EEV15	MODERN CONTROL SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide knowledge on design in state variable form.
- To provide knowledge in phase plane analysis.
- To give basic knowledge in describing function analysis.
- To study the design of optimal controller.
- To study the design of optimal estimator including Kalman Filter.

PRE-REQUISITE: NIL**UNIT-I STATE VARIABLE DESIGN 9**

Introduction to state model - effect of state feedback - Necessary and Sufficient Condition for Arbitrary Pole placement - pole placement design - Design of state observers - separation principle - 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 of linearization - Concept of phase portraits – Singular points – Limit cycles – Construction of phase portraits – 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 – Describing function 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 of Ricatti's equation – Application examples.

UNIT-V OPTIMAL ESTIMATION 9

Optimal estimation – Kalman Bucy Filter - Solution by duality principle - Discrete systems - Kalman Filter - Application examples.

TOTAL: 45 PERIODS**TEXT BOOKS:**

1. K. P. Mohandas, "Modern Control Engineering", Sanguine Technical Publishers, 2006.
2. G. J. Thaler, "Automatic Control Systems", Jaico Publishing House, 1993.
3. M.Gopal, "Modern Control System Theory", New Age International Publishers, 2002.

REFERENCES:

1. William S Levine, "Control System Fundamentals," The Control Handbook, CRC, Press, Tayler and Francies Group, 2011.
2. Ashish Tewari, 'Modern Control Design with Matlab and Simulink', John Wiley, New Delhi, 2002.
3. K. Ogata, 'Modern Control Engineering', 4th edition, PHI, New Delhi, 2002.
4. T. Glad and L. Ljung, "Control Theory –Multivariable and Non-Linear Methods", Taylor & Francis, 2002.
5. D.S.Naidu, "Optimal Control Systems" First Indian Reprint, CRC Press, 2009.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Develop state model for pole placement. (K3)
- Design state observers. (K3)
- Construct phase plane trajectories using isocline method for the given system. (K3)
- Derive describing function for various non linear systems. (K3)
- Explain the optimal control with examples. (K3)
- Explain optimal estimation for discrete system and design Kalman filters. (K3)

TEXT BOOKS:

1. Hamdy A.Taha “Operations Research – An Introduction”, MacMillan India Ltd., 10thEdition, 2017.
2. Panneerselvam R, “Operations Research”, Prentice Hall India, 2016.
3. Hira.D Gupta.P.K, ”Operations Research”, S.Chand Publications, 1st Edition, Reprint 2016

REFERENCES:

1. G.Srinivasan, “Operations Research: Principles and Applications”, PHI Ltd., 2016.
2. Kanti swarup Gupta.P.K, Man Muhan”, Operations Research: Sultan Chand & Sons India Ltd., 12th Edition, New Delhi 2016.
3. Philips, Ravindran and Solberg, “Operations Research principle and practise”, John Wiley, 2016.
4. Hiller and Liberman, Introduction to Operations Research, McGraw Hill, 2015.
5. Ramamurthy P, “Operations Research”, New age International Publishers, 2nd edition, 2007.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Solve Linear Programming Problems by appropriate technique. K(3)
- Determine the performance characteristics such as time and cost in solving shortest route, transportation problems with an appropriate model. K(3)
- Solve the given assignment problem with an appropriate method. K(3)
- Determine the optimal solution for a project scheduling problem. K(3)
- Determine the order quantity of goods under different constraints. K(3)
- Determine the solutions to single and multi channel queuing problems. K(3)

20EEV21	PROFESSIONAL ELECTIVE – II SMART GRID	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart knowledge about the following topics:

- Introduction to smart grid and compare this with conventional grid
- Smart Grid technologies both in transmission and distribution side
- Different smart meters and advanced metering infrastructure
- Power quality management issues in Smart Grid.
- The high performance computing for Smart Grid applications

PRE-REQUISITE:

Course Code: 20EE402

Course Name: Transmission and Distribution

UNIT - I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, National and International Initiatives in Smart Grid.

UNIT - II SMART GRID TECHNOLOGIES (TRANSMISSION) 9

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control.

UNIT - III SMART GRID TECHNOLOGIES (DISTRIBUTION) 9

DMS, Volt/VAR control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plugin Hybrid Electric Vehicles (PHEV).

UNIT - IV SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure(AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU), Intelligent Electronic Devices(IED)&their application for monitoring & protection.

UNIT - V POWER QUALITY MANAGEMENT IN SMART GRID AND SMART GRID APPLICATIONS 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit. Local Area Network(LAN),House Area Network(HAN), Wide Area Network(WAN), Broad band over Power line(BPL),IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

1. Vehbi C. Gungor, Dilan Sahin, Taskin Kocak, Salih Ergut, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, “Smart Grid Technologies: Communication Technologies and Standards” IEEE Transactions On Industrial Informatics, Vol.7, No.4, November 2011.
2. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang “Smart Grid – The New and Improved Power Grid: A Survey”, IEEE Transaction on Smart Grids, vol.14, 2012.
3. James Momohe “Smart Grid: Fundamentals of Design and Analysis,”, Wiley-IEEE Press, 2012.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Discuss the functions, opportunities, challenges and benefits of Smart Grid K(2)
- Describe the Smart energy resources and Transmission systems K(2)
- Explain the different Smart Grid distribution technologies K(2)
- Discuss the function of different smart meters and advanced metering infrastructure. K(2)
- Summarize the power quality management in Smart Grids K(2)
- Describe the basic service on LAN, WAN and Cloud Computing for Smart Grid applications. K(2)

TEXT BOOKS:

1. K.Venkataratnam, 'Special Electrical Machines', Universities Press (India) Private Limited, 2008.
2. T. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 2009
3. E.G. Janardanan, 'Special electrical machines', PHI learning Private Limited, Delhi, 2014.

REFERENCES:

1. Miller T J E, 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press, Oxford, 2008.
2. Kenjo T and Nagamori S, 'Permanent Magnet and Brushless DC Motors', Clarendon Press, London, 1986.
3. R.Krishnan, 'Switched Reluctance Motor Drives - Modeling, Simulation, Analysis, Design and Application', CRC Press, New York, 2014.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the construction and Principle of operation of stepper motor (K2)
- Discuss the construction and Principle of operation of SRM (K2)
- Describe the construction and Principle of operation of Permanent Magnet Brushless DC Motor (K2)
- Explain the operation Microprocessor Based controller for PMSM (K2)
- Discuss the Principle of operation of Permanent Magnet Synchronous Motor (K2)
- Describe the construction and Principle of operation of Synchronous Reluctance Motors (K2)

20EEV23	ELECTRIC VEHICLES AND POWER MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

To impart knowledge about the following topics:

- To understand the concept of electrical vehicles and its operations
- To compare the concept of EV with hybrid and conventional Electric vehicles
- To understand the need of power electronics converters control in DC and AC drives.
- To provide knowledge about various possible energy storage technologies that can be used in electric vehicles
- To discuss alternative energy storage systems

PRE-REQUISITE:

Course Code: 20EE401

Course Name: Electrical Machines – II

UNIT - I ELECTRIC VEHICLES AND VEHICLE MECHANICS 9

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings, Comparisons of EV with internal combustion Engine vehicles, Fundamentals of vehicle mechanics

UNIT - II ARCHITECTURE OF EV's AND POWER TRAIN COMPONENTS 9

Architecture of EV's and HEV's – Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes

UNIT - III CONTROL OF DC AND AC DRIVES 9

DC/DC chopper based four quadrant operations of DC drives – Inverter based V/f Operation (motoring and braking) of induction motor drive system – Induction motor and permanent motor based vector control operation – Switched reluctance motor (SRM) drives

UNIT - IV BATTERY ENERGY STORAGE SYSTEM 9

Battery Basics, Different types, Battery Parameters, Mathematical modeling of lead acid Batteries, Traction Batteries

UNIT - V ALTERNATIVE ENERGY STORAGE SYSTEMS 9

Fuel cell – Characteristics- Types – hydrogen Storage Systems and Fuel cell EV – Ultra capacitors

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals" CRC Press, Taylor & Francis Group, Second Edition, 2016
2. Mehrdad Ehsani, Yimin Gao, Stefano Longo, Kambiz Ebrahimi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", CRC Press, Third Edition, 2019

REFERENCES:

1. Ali Emadi, Mehrdad Ehsani, John M. Miller, "Vehicular Electric Power Systems", Special Indian Edition, Marcel Dekker, Inc 2010
2. Simona Onori, Lorenzo Serrao, "Hybrid Electric Vehicles Energy Management Strategies", Springer, 2015
3. Xiong, Rui, "Battery Management Algorithm for Electric Vehicles", Springer, 2020

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Demonstrate the operation of Electric vehicles and various energy storage technologies for electrical vehicles (K2)
- Explain the Architecture of EV's and Power Train Components (K2)
- Discuss the Control of DC drives (K2)
- Describe the Control of AC drives (K2)
- Explain about various types of Battery energy storage system (K2)
- Generalize the Alternative energy storage system (K2)

20EEV24	EMBEDDED C-PROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To expose the students to the fundamentals of embedded Programming
- To Introduce the GNU C Programming Tool Chain in Linux.
- To study the basic concepts of embedded C.
- To teach the basics of Python Programming
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts
- Acquired over the 5 Units of the subject for improved employability skills.

PRE-REQUISITE: NIL**UNIT - I BASIC C PROGRAMMING 9**

Typical C Program Development Environment - Introduction to C Programming - Structured Program Development in C - Data Types and Operators - C Program Control - C Functions - Introduction to Arrays.

UNIT - II EMBEDDED C 9

Adding Structure to 'C' Code: Object oriented programming with C, Header files for Project and Port, Examples. Meeting Real-time constraints: Creating hardware delays - Need for timeout mechanism - Creating loop timeouts - Creating hardware timeouts.

UNIT - III C PROGRAMMING TOOL-CHAIN IN LINUX 9

C preprocessor - Stages of Compilation - Introduction to GCC - Debugging with GDB - The Makeutility - GNU Configure and Build System - GNU Binary utilities - Profiling - using gprof - Introduction to GNU C Library.

UNIT - IV PYTHON PROGRAMMING 9

Introduction - Parts of Python Programming Language - Control Flow Statements - Functions – Strings - Lists - Dictionaries - Tuples and Sets.

UNIT - V MODULES, PACKAGES AND LIBRARIES IN PYTHON 9

Python Modules and Packages - Creating Modules and Packages - Practical Example - Libraries for Python - Library for Mathematical functionalities and Tools - Numerical Plotting Library - GUI Libraries for Python - Imaging Libraries for Python - Networking Libraries.

TOTAL: 45 PERIODS**TEXT BOOKS:**

1. Michael J Pont, "Embedded C", Addison-Wesley, Anim print of Pearson Education, 2002

REFERENCES:

1. Paul Deitel and Harvey Deitel, "C How to Program", 8th Edition, Pearson Education Limited, 2016.
2. William von Hagen, "The Definitive Guide to GCC", 2nd Edition, Apress Inc., 2006.
3. Noel Kalicharan, "Learn to Program with C", Apress Inc., 2015.
4. Steve Oualline, "Practical C programming", O'Reilly Media, 1997.
5. Fabrizio Romano, "Learn Python Programming", Second Edition, Packt Publishing, 2018.
6. John Paul Mueller, "Beginning Programming with Python for Dummies", 2nd Edition, John Wiley & Sons Inc., 2018.
7. Mark Lutz, "Programming Python", 4th Edition, O'Reilly Media Inc., 2010

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Demonstrate C programming and its salient features for embedded systems (K2)
- Deliver insight into various programming languages/software compatible to embedded process development with improved design & programming skills. (K3)
- Develop knowledge on C programming in Linux environment. (K2)
- Possess ability to write python programming for Embedded applications. (K2)
- Develop the Modules, Packages and Libraries for Python. (K2)
- Have improved Employability and entrepreneurship capacity due to knowledge upgradation on recent trends in embedded programming skills. (K2)

REFERENCES:

1. L. Ljung, System Identification - Theory for the User, 2nd edition, PTR Prentice Hall, Upper Saddle River, N.J., 1999.
2. K. S. Narendra and A. M. Annaswamy, Stability Adaptive Systems, Prentice-Hall, 1989.
3. H. K. Khalil, Nonlinear Systems, Prentice Hall, 3rd edition, 2002.
4. William S. Levine, "Control Systems Advanced Methods, the Control Handbook, CRC Press 2011.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the various system identification techniques and features of adaptive control. (K2)
- Explain the concept of system identification and adaptive control (K2)
- Explain about Black-box approach based system identification (K2)
- Discuss the batch and recursive identification. (K2)
- Explain about the computer controlled systems. (K2)
- Explain the concept for adaptive control schemes (K2)

20EEV26	COMPUTER ORGANIZATION AND ARCHITECTURE	L	T	P	C
		3	0	0	3

OBJECTIVES:

To learn the fundamentals of a computer system and operations.

- To learn the arithmetic and logic unit and implementation of fixed-point and floating point arithmetic unit.
- To learn the basics of pipelined execution.
- To understand parallelism and multi-core processors
- To understand the memory hierarchies and different ways of communication with I/O devices

PRE-REQUISITE: NIL**UNIT - I FUNDAMENTALS OF A COMPUTER SYSTEM 9**

Functional Units – Basic Operational Concepts- Bus structures – Performance Metrics – Instructions: Language of the Computer – Operations, Operands – Instruction Set Architecture- Instruction representation- RISC and CISC Architectures – Amdahl's Law – Logical operations – decision making – MIPS Addressing.

UNIT - II ARITHMETIC FOR COMPUTERS 9

ALU design -Addition and Subtraction – Multiplication – Division – Floating Point Representation – Floating Point Operations – Subword Parallelism.

UNIT - III PROCESSOR AND CONTROL UNIT 9

Components of the Processor - Hardwired control – Micro programmed control – Nano programming-A Basic MIPS implementation – Building a Datapath – Control Implementation Scheme – Pipelining – Pipelined data path and control – Hazards – Structural, Data and Control Hazards –Exception handling. Building blocks of Raspberry-pi.

UNIT - IV PARALLELISIM 9

Parallel processing challenges – Instruction Level Parallelism - Exploitation of more ILP – Hardware and Software Approaches – Dynamic Scheduling – Speculation – Compiler Approaches – Multiple Issue Processors - ILP and Thread Level Parallelism-Flynn's classification – SISD, MIMD, SIMD, SPMD, and Vector Architectures - Hardware multithreading – Multi-core processors and other Shared Memory Multiprocessors - Introduction to Graphics Processing Units, Clusters, Warehouse Scale Computers and other Message-Passing Multiprocessors.

UNIT - V MEMORY & I/O SYSTEMS 9

Memory Hierarchy - memory technologies – cache memory – measuring and improving cache performance – virtual memory- Memory management techniques – Associative memories - TLB's – Accessing I/O Devices – Interrupts – Direct Memory Access – Bus structure – Bus operation – Arbitration – Interface circuits - USB. Case Study: Design of Memory Systems using Raspberry Pi.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, 5th Edition, Morgan Kaufmann / Elsevier, 2014.
2. Carl Hamacher, Zvonko Vranesic, Safwat Zaky and Naraig Manjikian, Computer Organization and Embedded Systems, 6th Edition, Tata McGraw Hill, 2012.

REFERENCES:

1. John L. Hennessey and David A. Patterson, Computer Architecture – A Quantitative Approach, Morgan Kaufmann / Elsevier Publishers, 5th Edition, 2012.
2. John P. Hayes, Computer Architecture and Organization, 3rd Edition, Tata McGraw Hill, 2012.
3. William Stallings, Computer Organization and Architecture – Designing for Performance, Eighth Edition, Pearson Education, 2010.
4. Learning Computer Architecture using Raspberry pi – EbenUpton, Jeffrey Duntemann 2016 (1st Edition).

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the computer organization components, instructions and addressing modes. (K2)
- Compute the arithmetic operations such as Addition, Subtraction, Multiplication and Division. (K3)
- Discuss the basics of MIPS implementation and pipelining. (K2)
- Illustrate the basic concepts of parallelism, multi-core processor, GPU & Clusters. (K2)
- Describe the memory technologies & I/O systems. (K2)
- Utilize Raspberry-pi for demonstrating memory systems (K3).

	PROFESSIONAL ELECTIVE – III				
20EEV31	FLEXIBLE AC TRANSMISSION SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart knowledge about the following topics:

- The start-of-art of the power system
- Performance of power systems with FACTS controllers.
- FACTS controllers for load flow and dynamic analysis

PRE-REQUISITE:

Course Code: 20EE402

Course Name: Transmission and Distribution

UNIT - I INTRODUCTION 9

Real and reactive power control in electrical power transmission lines–loads & system compensation-Uncompensated transmission line–shunt and series compensation.

UNIT - II STATIC VAR COMPENSATOR (SVC) AND APPLICATIONS 9

Voltage control by SVC–Advantages of slope in dynamic characteristics–Influence of SVC on system voltage–Design of SVC voltage regulator–TCR-FC-TCR-Modeling of SVC for power flow and fast transient stability– Applications: Enhancement of transient stability –Steady state power transfer –Enhancement of power system damping.

UNIT - III THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) AND APPLICATIONS 9

Operation of the TCSC–Different modes of operation–Modelling of TCSC, Variability reactance model– Modelling for Power Flow and stability studies. Applications: Improvement of the system stability limit–Enhancement of system damping.

UNIT - IV VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS 9

Static Synchronous Compensator (STATCOM)–Principle of operation–V-I Characteristics. Applications: Steady state power transfer-enhancement of transient stability-prevention of voltage instability. SSSC-operation of SSSC and the control of power flow–modelling of SSSC in load flow and transient stability studies- Dynamic voltage restorer (DVR).

UNIT - V ADVANCED FACTS CONTROLLERS 12

Interline DVR (IDVR) - Unified Power flow controller (UPFC) - Interline power flow controller (IPFC) - Unified Power quality conditioner (UPQC).

TOTAL: 45 PERIODS

TEXT BOOKS:

1. R.Mohan Mathur, Rajiv K.Varma, “Thyristor–Based Facts Controllers for Electrical Transmission Systems”, IEEE press and JohnWiley&Sons,Inc,2002.
2. NarainG. Hingorani, “Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems”, Standard Publishers Distributors,Delhi-110006,2011.
3. T.J.E Miller, Power Electronics in power systems, John Wiley and sons.

REFERENCES:

1. K.R. Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International (P) Limited, Publishers, New Delhi, 2008
2. A.T.John, "Flexible A.C.Transmission Systems", Institution of Electrical and Electronic Engineers (IEEE), 1999.
3. V.K.Sood, HVDC and FACTS controllers–Applications of Static Converters in Power System, APRIL2004, Kluwer Academic Publishers,2004.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Develop analytical model of FACTS controller for power system application. (K2)
- Explain the concepts about load compensation techniques. (K2)
- Explain about facts devices. (K2)
- Discuss the start-of-art of the power system (K2)
- Describe the performance of steady state and transients of facts controllers. (K2)
- Discuss about advanced FACTS controllers. (K2)

20EEV32

SOLID STATE DRIVES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart the basic knowledge of Electrical Drives.
- To analyze the operation of controlled rectifier.
- To analyze the operation of chopper fed DC Drives.
- To study and understand the operation and performance of Induction motor drives.
- To study and understand the operation and performance of synchronous motor drives.

PRE-REQUISITE:

Course Code: 20EE302, 20EE304, 20EE401, 20EE502

Course Name: Electron Devices and Circuits, Electrical Machines-I, Electrical Machines-II, Power Electronics.

UNIT - I DRIVE CHARACTERISTICS 9

Introduction : drive system, types, choice of electrical drives; Dynamics of electrical drives - fundamental torque equation, multi-quadrant operation, equivalent values of drive parameters, components of load torques, classification of load torques, steady state stability, modes of operation.

UNIT - II DC MOTOR DRIVES 9

DC motor Fundamental relations – Steady state analysis of single phase semi converter, single phase and three phase full converter fed separately excited DC motor drive – continuous conduction – Time ratio and current limit control – chopper fed dc motor drives - single, two and 4 quadrant operations.

UNIT - III INDUCTION MOTOR DRIVES 9

Speed control – Stator control: Stator Voltage Control – Constant voltage variable frequency operation - V/f control - VSI and CSI fed induction motor drives and Closed loop control - Rotor control: Rotor resistance control - Qualitative treatment of slip power recovery scheme – Introduction to Vector Controlled Induction Motor Drives.

UNIT - IV SYNCHRONOUS MOTOR DRIVES 9

Speed control - V/f control - separate and self-control of synchronous motor drives using load commutated thyristor inverter - Margin angle control and power factor control - Permanent magnet AC motor drives - Applications.

UNIT - V DESIGN OF CONTROLLERS FOR DC DRIVES 9

Transfer function of separately excited DC motors / load and converter - Closed loop control of armature and field weakening control - Design of controllers: Current controller and speed controller - Converter selection and characteristics - Microprocessor/ Microcontroller based control of drives.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Gopal K.Dubey, 'Fundamentals of Electrical Drives', Narosa Publishing House, Second Edition, 2015.
2. Krishnan R., 'Electric Motor & Drives: Modelling, Analysis and Control', Pearson Education, 2015

REFERENCES:

1. Bimal K Bose, 'Modern Power Electronics and AC Drives', Pearson Education, 2016.
2. Vedam Subramanyam, 'Electric Drives – Concepts and Applications', McGraw Hill, Second Edition, 2010
3. Pillai S.K., 'A First Course on Electrical Drives', New Age International Publishers, Third Edition, 2013.
4. Muhammad H. Rashid, 'Power Electronics: Circuits, Devices and Applications', Pearson Education, 4th Edition, 2017.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the basics and importance of electric drives. (K2)
- Explain the operation of the various converter fed separately excited dc motor drives. (K2)
- Describe the operation of the various Chopper fed separately excited dc motor drives. (K2)
- Explain the various solid state speed control methods of induction motor drives. (K2)
- Discuss the various speed control methods of synchronous motor drives and applications. (K2)
- Apply the knowledge of Electrical Engineering fundamentals to develop current and speed controllers for a closed loop solid state dc motor drive. (K2)
- Apply the ethical principles, function effectively as an individual and communicate effectively on the assigned activities. (Activity Based to map higher order POs) (K2)

20EEV33	ELECTRIC VEHICLE DESIGN, MECHANICS AND CONTROL	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To learn the basics of EV and vehicle mechanics
- To know the EV architecture
- To study the energy storage system concepts
- To derive model for batteries and to know the different types of batteries and its charging methods
- To learn the control preliminaries for DC-DC converters.

PRE-REQUISITE: NIL

UNIT - I INTERNAL COMBUSTION ENGINES 6

IC Engines, BMEP and BSFC, Vehicle Fuel Economy, Emission Control Systems, Treatment of Diesel Exhaust Emissions.

UNIT - II ELECTRIC VEHICLES AND VEHICLE MECHANICS 6

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings - Comparisons of EV with internal combustion Engine vehicles – Fundamentals of vehicle mechanics.

UNIT - III BATTERY MODELING, TYPES AND CHARGING 6

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 6

Control Design Preliminaries - Introduction - Transfer Functions — Bode plot analysis for First order and second order systems - Stability - Transient Performance- Power transfer function for boost converter – Gain margin and Phase margin study - open loop mode.

UNIT - V CONTROL OF AC MACHINES 6

Introduction - Reference frame theory, basics-modeling of induction and synchronous machine in various frames – Vector control – Direct torque control.

TOTAL: 30 PERIODS

LAB COMPONENT: 30 PERIODS

1. Develop a model that could estimate Soc and SoH of Li-Ion Battery.
2. Modelling and thermal analysis of Li-Ion Battery.
3. Simulation of boost converter and calculating gain and phase margin from the transfer function.
4. Simulation of vector control of induction motor

TOTAL: 60 PERIODS

REFERENCES:

1. Electric and Hybrid Vehicles, Design Fundamentals, Third Edition, Iqbal Husain, CRC Press, 2021.
2. Power Electronic Converters, : Dynamics and Control in Conventional and Renewable Energy Applications, Teuvo Suntio, Tuomas Messo, Joonas Puukko, 1st Edition, Wiley-VCH.
3. Ali Emadi, Mehrdad Ehsani, John M.Miller, "Vehicular Electric Power Systems", Special Indian Edition, Marcel dekker, Inc 2003,1st Edition.
4. C.C.Chan and K.T.Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001, 1st Edition.
5. WieLiu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, John Wiley & Sons, 2017, 2nd Edition.
6. Dynamic Simulation of Electric Machinery using MATLAB, Chee Mun Ong, Prentice Hall, 1997, 1st Edition.
7. Electrical Machine Fundamentals with Numerical Simulation using MATLAB / SIMULINK, Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley, 2021, 1st Edition.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Describe the concepts related with EV, HEV and to compare the same with internal combustion engine vehicles. (K2)
- Discuss the fundamentals of vehicle mechanics (K2)
- Explain the concepts related with batteries and parameters of battery (K2)
- Demonstrate the battery and to study the research and development for batteries (K2)
- Determine the gain margin & phase margin for various types of transfer functions of boost converter (K2)
- Demonstrate the Control of AC Machines (K2)

20EEV34	EMBEDDED SYSTEM DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explain Building Blocks of a Embedded System and software Tools.
- To understand role of Input/output interfacing with Bus Communication protocol.
- To understand ISR and scheduling for multi-task process.
- To introduce the basics of a Real time operating system.
- To discuss applications based on embedded design approaches.

PRE-REQUISITE: NIL**UNIT – I INTRODUCTION TO EMBEDDED SYSTEMS 9**

Introduction to Embedded Systems – The build process for embedded systems - Structural units for an Embedded microcontroller , selection of processor & memory devices- DMA – Memory management methods - Timer and Counting devices, Watchdog Timer, Real Time Clock - IDE, assembler, compiler, linker, simulator, debugger, In-circuit emulator, Target Hardware Debugging, Boundary Scan.

UNIT – II EMBEDDED NETWORKING 9

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

UNIT - III INTERRUPTS SERVICE MECHANISM AND DEVICE DRIVERS 9

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

UNIT - IV RTOS BASED EMBEDDED SYSTEM 9

Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Pre emptive and non-pre emptive scheduling, Task communication shared memory, message passing, Inter process Communication – synchronization between processes-semaphores, Mailbox, pipes, priority inversion, priority inheritance, comparison of commercial Real time Operating systems: VxWorks, μ C/OS-II, RT Linux.

UNIT - V EMBEDDED SYSTEM APPLICATION WITH DEVELOPMENT 9

Case Study: Washing Machine - Automotive Application - RFID-System, Application, Embedded Product Development Life Cycle, Objective, Need, and different Phases & Modelling of the EDLC.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Rajkamal, 'Embedded System-Architecture, Programming, Design', Mc Graw Hill, 2013
2. Peckol, 'Embedded system Design', John Wiley & Sons, 2010
3. Shibu. K.V, 'Introduction to Embedded Systems', Tata Mcgraw Hill, 2009

REFERENCES:

1. Elicia White, 'Making Embedded Systems', O' Reilly Series SPD,2011
2. Tammy Noergaard, 'Embedded Systems Architecture', Elsevier, 2006
3. Han-Way Huang, 'Embedded system Design Using C8051', Cengage Learning, 2009
4. Rajib Mall, 'Real-Time systems Theory and Practice', Pearson Education, 2007

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the basic build process of embedded systems (K2)
- Describe the different types of I/O device ports, buses and different interfaces for data transfer in embedded networking (K2)
- Explain the interrupt service mechanism and device drivers. (K2)
- Explain the basic concept of Real Time Operating Systems (K2)
- Apply the knowledge of programming concepts of Embedded Systems for various applications (K3)
- Explain the different phases and modeling of the EDLC. (K2)

20EEV35	OPTIMAL CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To highlight the significance of optimal control in process industries and the different methods of optimization
- To introduce the concept of variational approach for the design of optimal control system
- To formulate linear quadratic optimal control strategy with specified degree of stability
- To impart knowledge about discrete time linear state regulator system and discrete time linear quadratic tracking system
- To illustrate the application of dynamic programming and HJB equation for the design of constrained and time optimal control systems

PRE-REQUISITE:

Course Code: 20EE504

Course Name: Control Systems

UNIT – I INTRODUCTION TO OPTIMAL CONTROL 9

Statement of optimal Control problem - problem formulation and forms of optimal control - performance measures - various methods of optimization - Linear programming - nonlinear programming.

UNIT – II CALCULUS OF VARIATIONS 9

Basic concepts – variational problem - Extreme functions with conditions - variational approach to optimal control systems.

UNIT - III LINEAR QUADRATIC OPTIMAL CONTROL SYSTEM 9

Problem formulation - finite time LQR - infinite time LQR - Linear Quadratic tracking system – LQR with a specified degree of stability.

UNIT - IV DISCRETE TIME OPTIMAL CONTROL SYSTEM 9

Variational calculus for DT system – DT optimal control system - DT linear state regulator system - DT linear quadratic tracking system .

UNIT - V PONTYAGIN MINIMUM PRINCIPLE 9

Pontryagin minimum principle - Dynamic programming – Hamilton - Jacobi - Bellman equation - LQR system using HJB equation – Time optimal control – fuel optimal control system -optimal control system with constraints.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Donald E. Kirk, Optimal Control Theory – An Introduction, Dover Publications, Inc. Mineola, New York, 2012, 10th Edition.

REFERENCES:

1. D. Subbaram Naidu, Optimal Control Systems, CRC Press, New York, 2003, 1st 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.
3. Lewis F.L. Draguna Vrabia, Syrmos V.L, Optimal control, John Wiley & sons, 2012.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Formulate the optimization problem based on the requirements and evaluate the performance of optimal controller (K2)
- Apply the variational approach for optimal control systems with conditions (K2)
- Differentiate finite time LQR and infinite time LQR and design linear quadratic tracking system (K2)
- Analyze discrete time optimal control systems used in different applications (K2)
- Design constrained optimal control system and time optimal control system (K3)
- Design optimal control system with constraints. (K2)

20EEV36	BLOCKCHAIN TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Comprehend the structure of a Blockchain networks.
- Evaluate security issues relating to Blockchain and cryptocurrency.
- Design and analyze the applications based on Blockchain technology

PRE-REQUISITE: NIL

UNIT - I INTRODUCTION TO BLOCKCHAIN 10

History, Digital Money to Distributed Ledgers, Design Primitives, Protocols, Security, Consensus, Permissions, Privacy

UNIT - II BLOCKCHAIN ARCHITECTURE, DESIGN AND CONSENSUS 8

Basic crypto primitives: Hash, Signature, Hash chain to Blockchain, Basic consensus mechanisms, Requirements for the consensus protocols, PoW and PoS, Scalability aspects of Blockchain consensus protocols

UNIT - III PERMISSIONED AND PUBLIC BLOCKCHAINS 9

Design goals, Consensus protocols for Permissioned Blockchains, Hyperledger Fabric, Decomposing the consensus process, Hyperledger fabric components, Smart Contracts, Chain code design, Hybrid models (PoS and PoW)

UNIT - IV BLOCKCHAIN CRYPTOGRAPHY 9

Different techniques for Blockchain cryptography, privacy and security of Blockchain, multi-sig concept

UNIT - V RECENT TRENDS AND RESEARCH ISSUES IN BLOCKCHAIN 9

Scalability, secure cryptographic protocols on Blockchain, multiparty communication, FinTech and Blockchain applicability

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Andreas Antonopoulos,-Mastering Bitcoin, Programming the Open Blockchain,2017
2. Melanie Swan,-Blockchain, Blueprint for a new Economy, 1st edition, 2015

REFERENCES:

1. Jonathan B Morley- That Book on Blockchain: A One-Hour Intro, 2017.
2. Daniel Drescher-Blockchain Basics: A Non-Technical Introduction in 25 Steps 1st Edition, 2017.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Discuss the basic of block chain in terms of protocols and security and privacy (K2)
- Explain the crypto primitives of block chain architecture (K2)
- Illustrate the appropriate Consensus design for application protocol (K2)
- Apply Hyper ledger Fabric to implement the Block chain (K3)
- Apply various cryptographic techniques in Block chain cryptography, privacy and security (K3)
- Discuss the research issues of Block chain (K2)

	PROFESSIONAL ELECTIVE – IV				
20EEV41	ENERGY AUDITING AND MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart knowledge on the following Topics

- Awareness about importance of energy management and auditing.
- Understanding the Energy management on various electrical motors.
- Understanding the Energy management on electric lighting systems.
- Apply the different types of metering methods of energy management and auditing
- Provide the economic models for energy and load management.

PRE-REQUISITE:

Course Code: 20EE304, 20EE401, 20EE402

Course Name: Electrical Machines-I, Electrical Machines-II, Transmission and Distribution

UNIT - I INTRODUCTION 9

Basics of Energy – Need for energy management – Energy accounting – Energy monitoring, targeting and reporting – Energy audit process.

UNIT - II ENERGY MANAGEMENT FOR MOTORS AND COGENERATION 9

Energy management for electric motors – Transformer and reactors – Capacitors and synchronous machines, energy management by cogeneration – Forms of cogeneration – Feasibility of cogeneration – Electrical interconnection.

UNIT - III LIGHTING SYSTEMS 9

Energy management in lighting systems – Task and the working space – Light sources – Ballasts – Lighting controls – Optimizing lighting energy – Power factor and effect of harmonics, lighting and energy standards..

UNIT - IV METERING FOR ENERGY MANAGEMENT 9

Metering for energy management – Units of measure – Utility meters – Demand meters – Paralleling of current transformers – Instrument transformer burdens – Multi tasking solid state meters, metering location vs requirements, metering techniques and practical examples.

UNIT - V ECONOMIC ANALYSIS AND MODELS 9

Economic analysis – Economic models – Time value of money – Utility rate structures – Cost of electricity – Loss evaluation, load management – Demand control techniques – Utility monitoring and control system – HVAC and energy management – Economic justification.

TOTAL: 45PERIODS

TEXT BOOKS:

1. Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, Guide to Energy Management, Fifth Edition, The Fairmont Press, Inc., 2006
3. Eastop T. D & Croft D. R, Energy Efficiency for Engineers and Technologists, Logman Scientific & Technical, ISBN-0-582-03184, 1990.

REFERENCES:

1. Reay D.A, Industrial Energy Conservation, 1st edition, Pergamon Press, 1977.
2. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.
3. Amit K. Tyagi, Handbook on Energy Audits and Management, TERI, 2003.
4. Electricity in buildings good practice guide, McGraw-Hill Education, 2016.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the importance of energy management and auditing. (K2)
- Describe energy management on different types of electrical equipment. (K3)
- Explain the Forms and feasibility of cogeneration (K3)
- Discuss the energy management on different types of lighting system and light sources. (K3)
- Describe the different types of metering methods of energy management and auditing. (K4)
- Explain the economic models for energy and load management. (K2)

20EEV42	CONTROL OF ELECTRICAL DRIVES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the DC drive control.
- To study and analyze the Induction motor drive control.
- To study and understand the Synchronous motor drive control.
- To study and analyze the SRM and BLDC motor drive control.
- To analyze and design the Digital control for drives.

PRE-REQUISITE:

Course Code: 20EE502
 Course Name: Power Electronics

UNIT - I CONTROL OF DC DRIVES 9

Losses in electrical drive system, Energy efficient operation of drives, block diagram /transfer function of self, separately excited DC motors --closed loop control-speed control current control - constant torque/power operation - P, PI and PID controllers--response Comparison.

UNIT - II CONTROL OF INDUCTION MOTOR DRIVE 9

VSI and CSI fed induction motor drives-principles of V/f control-closed loop variable frequency PWM inverter with dynamic braking- static Scherbius drives- power factor considerations--modified Kramer drives-principle of vector control- implementation-block diagram, Design of closed loop operation of V/f control of Induction motor drive systems.

UNIT - III CONTROL OF SYNCHRONOUS MOTOR DRIVES 9

Open loop VSI fed drive and its characteristics--Self-control--Torque control --Torque angle Control --Power factor control--Brushless excitation systems--Field oriented control --Design of closed loop operation of Self-control of Synchronous motor drive systems.

UNIT - IV CONTROL OF SRM AND BLDC MOTOR DRIVES 9

SRM construction - Principle of operation - SRM drive design factors-Torque controlled SRM-Block diagram of Instantaneous Torque control using current controllers and flux Controllers. Construction and Principle of operation of BLDC Machine -Sensing and logic switching scheme,- Sinusoidal and trapezoidal type of Brushless dc motors -- Block diagram of current controlled Brushless dc motor drive.

UNIT - V DIGITAL CONTROL OF DC DRIVE 9

Phase Locked Loop and micro-computer control of DC drives--Program flow chart for constant constant torque and constant horse power operations Speed detection and current sensing circuits and feedback elements.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Gopal K.Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, Second Edition, 2015.
2. Krishnan R., “ Electric Motor & Drives: Modelling, Analysis and Control”, Pearson Education, 2015

REFERENCES:

1. Bin Wu, High-Power Converters and AC Drives, Wiley-IEEE Press
2. Bimal K Bose, “Modern Power Electronics and AC Drives” Pearson Education, 2016.
3. R. Krishnan, Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design, and Applications, CRC press, 2001.
4. Werner Leonhard, Control of Electrical Drives, 3rd Edition, Springer, Sept., 2001.
5. R. Krishnan, Permanent Magnet Synchronous and Brushless DC Motor Drives, CRC press, 2001.
6. Murphy, J.M.D, Turnbull F.G, Thyristor control of AC motors,., Pergamon press, Oxford, 1988

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the various control strategies and controllers for DC Motor Drive systems. (K2)
- Discuss the various control strategies and controllers for Induction Motor Drive systems and develop the closed loop operation of V/f control of Induction motor drive systems. (K3)
- Describe the various control strategies and controllers for Synchronous Motor Drive systems. (K2)
- Explain the various control strategies and controllers for SRM Motor Drive systems. (K2)
- Discuss the various control strategies and controllers for BLDC Motor Drive systems. (K2)
- Explain the various Digital control for DC Motor Drive systems. (K2)

20EEV43	DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the different types of energy storage system.
- To study about the battery characteristic & parameters
- To model the types of batteries
- To know the concepts of battery management system and design the battery pack.
- To study about the battery testing, disposal and recycling

PRE-REQUISITE: NIL**UNIT - I ENERGY STORAGE SYSTEM 9**

Batteries: Lead Acid Battery, Nickel based batteries, Sodium based batteries, Lithium based batteries – Li-ion & Li-poly, Metal Air Battery, Zine Chloride battery; Ultra capacitors; Flywheel Energy Storage System; Hydraulic Energy Storage System; Comparison of different Energy Storage System **Suggested reading:** Study of different types of batteries

UNIT - II BATTERY CHARACTERISTICS & PARAMETERS 9

Cells and Batteries- conversion of chemical energy to electrical energy- Battery Specifications: Variables to characterize battery operating conditions and Specifications to characterize battery nominal and maximum characteristics; Efficiency of batteries; Electrical parameters Heat generation- Battery design- Performance criteria for Electric vehicles batteries- Vehicle propulsion factors- Power and energy requirements of batteries- Meeting battery performance criteria- setting new targets for battery performance.

UNIT - III BATTERY MODELLING 9

Approach to modelling batteries, simulation model of a rechargeable Li-ion battery, simulation model of a rechargeable NiCd battery, Parameterization of the NiCd battery model, Simulation examples.

UNIT - IV BATTERY PACK AND BATTERY MANAGEMENT SYSTEM 9

Selection of battery for EVs & HEVs, Traction Battery Pack design, Requirement of Battery Monitoring, Battery State of Charge Estimation methods, Battery Cell equalization problem, thermal control, protection interface, SOC Estimation, Energy & Power estimation, Battery thermal management system, Battery Management System: Definition, Parts: Power Module, Battery, DC/DC Converter, load, communication channel, Battery Pack Safety, Battery Standards & Tests.

UNIT - V BATTERY TESTING, DISPOSAL & RECYCLING 9

Chemical & structure material properties for cell safety and battery design, battery testing, limitations for transport and storage of cells and batteries, Recycling, disposal and second use of batteries. Battery Leakage: gas generation in batteries, leakage path, leakage rates. Ruptures: Mechanical stress and pressure tolerance of cells, safety vents, Explosions: Causes of battery explosions, explosive process, Thermal Runway: High discharge rates, Short circuits, charging and discharging. Environment and Human Health impact assessments of batteries, General recycling issues and drivers, methods of recycling of EV batteries.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric Hybrid Electric and Fuel Cell Vehicles", Taylor & Francis Group, 2010.
2. James Larminie, John Lowry, "Electric Vehicle Technology Explained", John Wiley & Sons Ltd, 2003.

REFERENCES:

1. Guangjin Zhao, "Reuse and Recycling of Lithium-Ion Power Batteries", John Wiley & Sons. 2017. (ISBN: 978-1-1193-2185-9)
2. Arno Kwade, Jan Diekmann, "Recycling of Lithium-Ion Batteries: The LithoRec Way", Springer, 2018. (ISBN: 978-3-319-70571-2)
3. Ibrahim Dinçer, Halil S. Hamut and Nader Javani, "Thermal Management of Electric Vehicle Battery Systems", John Wiley & Sons Ltd., 2016.
4. Chris Mi, Abul Masrur & David Wenzhong Gao, "Hybrid electric Vehicle- Principles & Applications with Practical Properties", Wiley, 2011.
5. G. Pistoia, J.P. Wiaux, S.P. Wolsky, "Used Battery Collection and Recycling", Elsevier, 2001. (ISBN: 0-444-50562-8)"

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Discuss about the different types of energy storage system. (K2)
- Describe about the battery characteristic & parameters. (K2)
- Explain the different types of batteries. (K2)
- Explain the concepts of battery pack design. (K2)
- Explain the concepts of battery management system (K2)
- Explain about the battery testing, disposal and recycling. (K2)

20EEV44	EMBEDDED CONTROL FOR ELECTRIC DRIVES	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To provide the control concept for electrical drives
- To emphasize the need of embedded systems for controlling the electrical drives
- To provide knowledge about various embedded system based control strategies for electrical drives
- To Impart the knowledge of optimization and machine learning techniques used for electrical drives
- To familiarize the high-performance computing for electrical drives

PRE-REQUISITE:

Course Code: 20EE304, 20EE401, 20EE505

Course Name: Electrical Machines-I, Electrical Machines-II, Microprocessors, Microcontrollers and Applications

UNIT - I INTRODUCTION TO ELECTRIC DRIVES 6

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 6

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

UNIT - III INDUCTION MOTOR CONTROL 6

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

UNIT - IV BLDC MOTOR CONTROL 6

Overview of BLDC Motor – Speed control methods – PWM techniques – Embedded processor based BDLC motor speed control.

UNIT - V SRM MOTOR CONTROL 6

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

TOTAL: 30 PERIODS

LABCOMPONENT:

30 PERIODS

1. Laboratory exercise: Use any System level simulator/MATLAB/open source platform to give hands-on training on simulation study on Electric drives and control.
 - a. Simulation of four quadrant operation and speed control of DC motor
 - b. Simulation of 3-phase inverter.
 - c. Simulation of Speed control of Induction motor using any suitable software package.
 - d. Simulation of Speed control of BLDC motor using any suitable software package.
 - e. Simulation of Speed control of SRM using any suitable software package
2. Seminar: IoT-based Control and Monitoring for DC Motor/any Electric drives.
3. Mini project.: Any Suitable Embedded processor-based speed control of Motors (DC/IM/BLDC/PMSM/SRM)

TOTAL: 60 PERIODS

TEXTBOOKS:

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.

REFERENCES:

1. Vedam Subramanyam, "Electric Drives–Concepts and Applications", Tata Mc Graw-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', Addison Wesley, 2nd Edition 2015.
4. Ron Sass and Anderew G.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.

List of Open Source Software/Learning website:

- 1) <https://archive.nptel.ac.in/courses/108/104/108104140/>
- 2) <https://www.embedded.com/mcus-or-dsps-which-is-in-motor-control/>
- 3) https://www.e3sconferences.org/articles/e3sconf/pdf/2019/13/e3sconf_SeFet2019_01004.pdf
- 4) <https://www.electronics-tutorials.ws/blog/pulse-width-modulation.html>
- 5) <http://kaliasgoldmedal.yolasite.com/resources/SEM/SRM.pdf>

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Interpret the significance of embedded control of electrical drive (K2)
- Developing knowledge of Machine learning and optimization techniques for motor control. (K2)
- Deliver in sight in to various control strategies for electrical drives. (K2)
- Explain the speed control operation of Embedded processor based induction motor. (K2)
- Discuss the speed control operation of Embedded processor based BDLC motor. (K2)
- Describe the speed control operation of Embedded processor based SRM motor. (K3)

20EEV45	PROCESS MODELING AND SIMULATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the process control loop and obtain the mathematical model of different processes.
- To educate on the conventional PID controller and its associated features and design the PID controller using different tuning techniques.
- To elaborate different types of control schemes such as cascade control, feed forward control etc.
- To educate on multivariable systems and multi-loop control.
- To educate on various industrial processes.

PRE-REQUISITE: NIL

UNIT - I PROCESS DYNAMICS 9

Need for process control – The process control loop – Continuous and batch processes – P & I diagram - Self-regulation - Interacting and non-interacting systems - Mathematical models of level, flow and thermal processes – Linearization of nonlinear systems.

UNIT - II PID CONTROLLER AND TUNING 9

Characteristic of ON-OFF, P, P+I, P+D and P+I+D control modes – Digital PID algorithm – Auto/manual transfer – Reset windup – Practical forms of PID controller – Evaluation criteria – IAE, ISE, ITAE and ¼ decay ratio – Tuning – Process reaction curve method and Z-N and Cohen-Coon techniques – Continuous cycling and damped oscillation methods – Auto-tuning.

UNIT - III ENHANCEMENT OF SINGLE-LOOP CONTROL & MODEL BASED CONTROL SCHEMES 9

Cascade control – Split-range control – Feed-forward control – Ratio control – Inferential control – override control – Smith predictor control scheme – Internal model control (IMC) – IMC PID controller – Dynamic matrix control – Generalized predictive control.

UNIT - IV MULTIVARIABLE SYSTEMS & MULTI-LOOP CONTROL 9

Multivariable systems – Transfer matrix representation – Poles and zeros of MIMO system - Introduction to multi-loop control – Process Interaction – Pairing of inputs and outputs – The relative gain array (RGA) – Properties and applications of RGA – Multi-loop PID controller – Decoupling control – Multivariable PID controller.

UNIT - V CASE-STUDIES 9

Model predictive control – Control schemes for distillation column, CSTR, four-tank system and pH.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Stephanopoulos G, "Chemical Process Control", Pearson, 2015.
2. Bequette WB, "Process Control: Modeling, Design and Simulation", Prentice Hall India, 2003.

REFERENCES:

1. Seborg DE, Mellichamp DA, & Edgar TF, "Process Dynamics and Control", Wiley, 2013.
2. Chidambaram M, "Computer Control of Processes", Narosa, 2006.
3. Luyben WL, "Process Modeling, Simulation and Control for Chemical Engineers", 2013.
4. Johnson CD, "Process Control Instrumentation Technology", Pearson, 2015.
5. Coughanowr DR & Le Blanc SE, "Process Systems Analysis and Control", McGraw Hill, 2013.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Ability to apply knowledge of mathematics, science, and engineering to the build and analyze models for flow, level, and thermal processes. (K2)
- Ability to design and implement P/PI/PID controllers to achieve desired performance for SISO processes. (K3)
- Ability to understand the techniques of Tuning processes (K2)
- Ability to understand and use different single-loop control and model based control schemes. (K2)
- Ability to analyze and design multivariable and multi-loop control systems. (K2)
- Ability to understand the various processes namely four-tank system, pH process, bioreactor, distillation column. (K2)

20EEV46	DATA STRUCTURES AND ALGORITHMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the concepts of ADTs
- To understand the basics of algorithm analysis
- To Learn linear data structures – lists, stacks, and queues
- To apply Tree and Graph structures
- To understand sorting, searching and hashing algorithms and their analysis.

PRE-REQUISITE:

Course Code: 20CS201

Course Name: Programming in C

UNIT - I INTRODUCTION TO DATA STRUCTURES AND ALGORITHM ANALYSIS 10

Introduction: Data Structures, Notion of an algorithm, Algorithm Efficiency and Analysis Framework, Asymptotic Notations and their properties. Linear Data Structures: Abstract Data Types (ADTs) – List ADT – Array-based implementation – Linked list implementation —Singly Linked Lists- Circularly Linked Lists- Doubly-Linked Lists – Applications of Lists –Polynomial Manipulation – All operations (Insertion, Deletion, Merge, Traversal). Implementation of algorithmic problems.

UNIT - II LINEAR DATA STRUCTURES – STACKS, QUEUES 8

Stack ADT – Operations – Applications– Evaluating arithmetic expressions- Conversion of Infix to postfix expression – Queue ADT – Operations – Circular Queue – Priority Queue – deQueue – Applications of Queues.

UNIT - III NON LINEAR DATA STRUCTURES – TREES 9

Tree ADT – Tree Traversals – Binary Tree ADT – Expression Trees – Applications of Trees – Binary Search Tree ADT –Threaded Binary Trees- AVL Trees – B-Tree – B+ Tree – Heap – Applications of heap.

UNIT - IV NON LINEAR DATA STRUCTURES – GRAPHS 9

Definition – Representation of Graph – Types of graph – Breadth-first traversal – Depth-first traversal – Topological Sort – Bi-connectivity – Cut vertex – Euler circuits – Applications of graphs.

UNIT - V SEARCHING, SORTING AND HASHING TECHNIQUES 9

Divide and Conquer Methodology: Comparison of Searching Techniques: Linear Search – Binary Search, Mathematical analysis of Binary Search. Sorting – Merge Sort, Quick Sort, Bubble sort – Selection sort – Insertion sort – Shell sort – Radix sort. Hashing- Hash Functions – Separate Chaining – Open Addressing – Rehashing – Extendible Hashing.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Mark Allen Weiss, — Data Structures and Algorithm Analysis in C, 2nd Edition Reprint, Pearson Education, 2002.
2. Reema Thareja, — Data Structures Using C, Second Edition, Oxford University Press, 2011.
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein – Introduction to Algorithms, MIT Press, Third Edition, 2009.

REFERENCES:

1. Stephen G. Kochan, — Programming in C, 3rd edition, Pearson Education, 2005.
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, — Fundamentals of Data Structures in C, Second Edition, University Press, 2008.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the concept of asymptotic notations and algorithmic efficiency with properties. (K2)
- Describe abstract data types and implement various algorithmic problems using arrays and linked list. (K2)
- Apply the different linear data structures like stack and queue to various computing problems. (K3)
- Build different types of trees and graphs and apply various operations and their applications. (K3)
- Analyze different sorting and searching techniques based on time and space complexity of the algorithms designed using divide and conquer methods. (K4)
- Develop suitable hashing algorithm for indexing data items into specific locations in a hash table considering collision resolution techniques. (K3)

	PROFESSIONAL ELECTIVE – V				
20EEV51	HIGH VOLTAGE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Causes of over voltages in Power System and protection methods.
- Breakdown phenomenon in Gas, Liquid, Vacuum, Solid and Composite Dielectrics
- Generation of high AC& DC voltages and Impulse voltage & Current.
- Various methods of measurement of High Voltages and Currents.
- Testing of power apparatus and insulation coordination

PRE-REQUISITE:

Course Code: 20EE201

Course Name: Electric Circuit Analysis

UNIT-I OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS 9

Introduction to over voltages - Natural Causes of over voltages - Charge formation in the clouds – Lightning phenomenon: Mechanism of lightning stroke, Mathematical modeling of lightning - Switching surges- Reflection and Refraction of Travelling waves-Protection against over voltages.

UNIT-II ELECTRICAL BREAKDOWN IN GAS, LIQUID and SOLID DIELECTRICS 9

Gaseous breakdown - Uniform field - Townsend criterion, Streamer theory -Pachen’s law - Non-uniform fields - Corona discharges - Vacuum breakdown - Conduction and breakdown in pure and commercial liquids - Breakdown mechanisms in solid dielectrics.

UNIT-III GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS 9

Generation of High DC Voltages: Voltage doubler, Cockcroft Walton Voltage multiplier and Vande-Graff generator- Generation of high AC voltages: Cascaded transformer, Resonant transformer, and Tesla coil -Generation of Impulse voltage: Single and Multistage impulse generator - MARX circuit and generation of impulse current - Tripping 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.

UNIT-V HIGH VOLTAGE TESTING OF ELECTRICAL APPARATUS 9

Terminologies and Definitions - High voltage testing of electrical power apparatus as per standards: Insulators, Bushings, Isolators, Circuit Breakers, Cables, Transformers, and Surge Arrester - Insulation Coordination.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Naidu M.S. and Kamaraju V., "High Voltage Engineering", McGraw Hill, 6th Edition, 2020.
2. Wadhwa C.L., "High Voltage Engineering", New age publishers, 3rd Edition, 2012.
3. Kuffel E. and Zaengl W.S., "High Voltage Engineering Fundamentals", Pergamon press, Oxford, London, 2005.

REFERENCES:

1. L.L. Alston, 'High Voltage Technology', Oxford University Press, First Indian Edition, 2011.
2. Mazen Abdel – Salam, Hussein Anis, Ahdab A-Morshedy, Roshday Radwan, High Voltage Engineering – Theory & Practice, Second Edition Marcel Dekker, Inc., 2010
3. Subir Ray, 'An Introduction to High Voltage Engineering' PHI Learning Private Limited, New Delhi, Second Edition, 2013.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Identify the causes of over voltage and its effects in power system. (K2)
- Explain the breakdown Mechanisms in Solid, Liquid, gases and Composite dielectrics. (K2)
- Analyze different type of Generating circuit for high voltage D.C and high voltage A.C. (K4)
- Explain the Measurement of A.C and D.C high voltage and current using appropriate method. (K2)
- Analyze the importance of power apparatus testing in Transient studies. (K4)
- Understand the concept of Insulation coordination. (K2)

20EEV52	SMPS AND UPS (20EE844)	L	T	P	C
		3	0	0	3

OBJECTIVES:

To impart knowledge about the following topics:

- Modern power electronic converters and its applications in electric power utility.
- Resonant converters and UPS

PRE-REQUISITE: Nil**UNIT - I DC-DC CONVERTERS 9**

Principles of step down and step up converters – Analysis and state space modeling of Buck, Boost, Buck- Boost and Cuk converters.

UNIT - II SWITCHED MODEPOWER CONVERTERS 9

Analysis and state space modeling of fly back, Forward, Push pull, Luo, Half bridge and full bridge converters - control circuits and PWM techniques.

UNIT - III RESONANT CONVERTERS 9

Introduction – classification - basic concepts - Resonant switch - Load Resonant converters - ZVS , Clamped voltage topologies - DC link inverters with Zero Voltage Switching - Series and parallel Resonant inverters - Voltage control.

UNIT - IV DC-AC CONVERTERS 9

Single phase and three phase inverters, control using various (sine PWM, SVPWM and PSPWM) techniques, various harmonic elimination techniques - Multilevel inverters - Concepts - Types: Diode clamped - Flying capacitor - Cascaded types - Applications.

UNIT - V V POWER CONDITIONERS, UPS& FILTERS 9

Introduction - Power line disturbances - Power conditioners – UPS: offline UPS, Online UPS, Applications – Filters: Voltage filters, Series-parallel resonant filters, filter without series capacitors, filter for PWM VSI, current filter, DC filters – Design of inductor and transformer for PE applications – Selection of capacitors.

TOTAL: 45 PERIODS**TEXT BOOKS:**

1. Simon Ang, Alejandro Oliva, " Power-Switching Converters", Third Edition, CRC Press, 2010.
2. Kjeld Thorborg, "Power Electronics – In theory and Practice", Overseas Press, First Indian Edition 2005.
3. M.H. Rashid – Power Electronics handbook, Elsevier Publication, 2001

REFERENCES:

1. Philip T Krein, " Elements of Power Electronics", Oxford University Press
2. Ned Mohan, Tore.M.Undel and, William. P.Robbins, Power Electronics converters, Applications and design- Third Edition- John Wiley and Sons- 2006

3. M.H. Rashid – Power Electronics circuits, devices and applications-third edition Prentice Hall of India New Delhi, 2007.
4. Erickson, Robert W, “Fundamentals of Power Electronics”, Springer, second edition, 2010.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the operation and state space modeling of DC-DC converters (K2)
- Describe the operation and state space modeling of switched mode power converters (K2)
- Discuss the basic concept and operation of resonant converters (K2)
- Summarize the PWM techniques for DC-AC converters (K2)
- Explain the operation of Power conditioners, UPS and its applications in electric power utility. (K2)
- Describe the operation of various types of filters (K2)

20EEV53	TESTING OF ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know various standardization procedures
- To learn the testing procedures for EV & HEV components
- To know the functional safety and EMC
- To realize the effect of EMC in EVs
- To study the effect of EMI in motor drives and in DC-DC converter system

PRE-REQUISITE:

Course Code: 20EEV23

Course Name: Electric Vehicles and Power Management

UNIT - I EV STANDARDIZATION 9

Introduction – Current status of standardization of electric vehicles, electric Vehicles and Standardization - Standardization Bodies Active in the Field — Standardization activities in countries like Japan. The International Electro Technical Commission – Standardization of Vehicle Components.

UNIT - II TESTING OF ELECTRIC MOTORS AND CONTROLLERS FOR ELECTRIC AND HYBRID ELECTRIC VEHICLES 9

Test Procedure Using M-G Set, electric motor, controller, application of Test Procedure, Analysis of Test Items for the Type Test - Motor Test and Controller Test (Controller Only).- Test Procedure Using Eddy Current Type Engine Dynamometer, Test Strategy, Test Procedure, Discussion on Test Procedure. Test Procedure Using AC Dynamometer.

UNIT - III FUNDAMENTALS OF FUNCTIONAL SAFETY AND EMC 9

Functional safety life cycle – Fault tree analysis – Hazard and risk assessment — software development – Process models – Development assessments –Configuration management – Reliability - Reliability block diagrams and redundancy - Functional safety and EMC - Functional safety and quality – Standards – Functional safety of autonomous vehicles.

UNIT - IV EMC IN ELECTRIC VEHICLES 9

Introduction - EMC Problems of EVs, EMC Problems of Motor Drive, EMC Problems of DC –DC Converter System, EMC Problems of Wireless Charging System, EMC Problem of Vehicle Controller, EMC Problems of Battery Management System, Vehicle EMC Requirements

UNIT - V EMI IN MOTOR DRIVE AND DC-DC CONVERTER SYSTEM 9

Overview - EMI Mechanism of Motor Drive System, Conducted Emission Test of Motor Drive System, IGBT EMI Source, EMI Coupling Path, EMI Modelling of Motor Drive System. EMI in DC-DC Converter, EMI Source, The Conducted Emission High-Frequency, Equivalent Circuit of DC-DC Converter System, EMI Coupling Path

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005, 1stEdition.
2. Electromagnetic Compatibility of Electric Vehicle, Li Zhai, Springer 2021, 1stEdition.

REFERENCES:

1. EMC and Functional Safety of Automotive Electronics, Kai Borgeest, IET2018, 1stEdition.
2. EMI/EMC Computational Modeling Handbook, Druce Archambeault, colinbranch, Omar M.Ramachi Springer 2012, 2ndEdition.
3. Automotive EMC, Mark Steffika, Springer 2013, 1stEdition.
4. Electric Vehicle Systems Architecture and Standardization Needs, Reports of the PPP European Green Vehicles Initiative, Beate Müller, Gereon Meyer, Springer 2015, 1stEdition.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Describe the status and other details of standardization of EVs (K2)
- Illustrate the testing protocols for EVs and HEV components (K2)
- Explain the safety cycle and need for functions safety for EVs (K2)
- Discuss the problems related with EMC for EV components. (K2)
- Determine the EMI in motor drive (K2)
- Determine the EMI in DC-DC converter system. (K2)

20EEV54	SMART SYSTEM AUTOMATION	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To introduce the smart system technologies and its role in real time applications
- To teach the architecture and requirements of Home Automation
- To provide an insight into smart appliances and energy management concepts
- To familiarize the design and needs of smart wearable devices
- To teach the basics of robotics and its role for automation.

PRE-REQUISITE: Nil

UNIT - I	INTRODUCTION		6
	Overview of a smart system – Hardware and software selection – Smart sensors and Actuators – Communication protocols used for smart systems.		
UNIT - II	HOME AUTOMATION		6
	Home Automation – System Architecture - Essential Components - Design Considerations: Control Unit, Sensing Requirements, Communication, Data Security.		
UNIT - III	SMART APPLIANCES AND ENERGY MANAGEMENT		6
	Significance of smart appliances for energy management Smart Meters: Significance, Architecture & Energy Measurement Technique – Security Considerations.		
UNIT - IV	SMART WEARABLE DEVICES		6
	Body Area Networks – Sensors – communication protocol for Wearable devices – Application of Smart Wearable in Healthcare & Activity Monitoring.		
UNIT - V	EMBEDDED SYSTEMS AND ROBOTICS		6
	Fundamental concepts in Robotics – Robots and Controllers components – Embedded processor based: pick and place robot – Mobile Robot Design - UAV.		

30 PERIODS

**LAB COMPONENTS:
PERIODS**

30

1. Laboratory exercise: Use Arduino / Rpi / any other Embedded processors to give hands on training to understand concepts related to smart automation.
 - a) Hands on experiments based on Ubidots & Thing speak / Open-source Analytics Platform
 - b) Design and implementation of a smart home system.
 - c) Bluetooth Based Home Automation Project using Android Phone
 - d) GSM Based Home Devices Control
 - e) Pick and place robots using Arduino / any suitable Embedded processor
2. Assignment: Revolution of Smart Automation system across the world and its current scope available in India
3. Mini project: Design of a Smart Automation system (for any application of students choice)

TOTAL: 30+30 = 60 PERIODS

TEXT BOOKS:

1. Grimm, Christoph, Neumann, Peter, Mahlknechand Stefan, Embedded Systems for Smart Appliances and Energy Management, Springer 2013, 1st Edition
2. Kazem Sohraby, Daniel Minoli and Taieb Znati, Wireless Sensor Networks Technology, Protocols, and Applications, John Wiley & Sons, 2007, 1st Edition
3. Nilanjan Dey, Amartya Mukherjee, Embedded Systems and Robotics with Open-Source Tools, CRCpress, 2016, 1st Edition

REFERENCES:

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

LIST OF OPEN SOURCE SOFTWARE / LEARNING WEBSITE:

1. <https://microcontrollerslab.com/home-automation-projects-ideas/>
2. <https://www.learnrobotics.org/blog/simple-robot/>
3. <https://robo-labor.com/homelab/en/iot>
4. https://electrovolt.ir/wpcontent/uploads/2018/03/Exploring_Raspberry_Pi_Molloy_Derek_ElectroVolt.ir_.pdf
5. [http://www.robot.bmstu.ru/files/books/\(Ebook%20-%20English\)%20Mcgraw-Hil,%20Pic%20Robotics%20--%20A%20Beginner'S%20Guide%20To%20Robotic.pdf](http://www.robot.bmstu.ru/files/books/(Ebook%20-%20English)%20Mcgraw-Hil,%20Pic%20Robotics%20--%20A%20Beginner'S%20Guide%20To%20Robotic.pdf)

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Discuss the overview and communication protocols used for smart systems. (K2)
- Explain the System Architecture, Essential Components and Design Considerations of Home Automation. Demonstrate the Bluetooth Based Home Automation Project using Android Phone. Design of a Smart Automation system (K3)
- Describe the Architecture, Energy Measurement Technique, Security Considerations of Smart Meters. Design and implementation of a smart home system. (K3)
- Summarize the function of Body Area Networks, Sensors, communication protocol and Applications of smart Wearable devices. Conduct the GSM Based Home Devices Control. (K3)
- Outline the Fundamental concepts and Controllers components of Robotics (K2)
- Design the Embedded processor based pick and place robot and Mobile Robot. Illustrate the Pick and place robots using Arduino / any suitable Embedded processor. (K3)

20EEV55	COMPUTER CONTROL OF PROCESSES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To represent the linear time invariant System in discrete State Space form
- To analyze the controllability, observability and stability of a Discrete time System.
- To estimate model parameters from input/output measurements
- To Design Digital Controllers
- To Design Multi-loop and Multivariable Controllers for multivariable system

PRE-REQUISITE: Nil**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 transfer functions – State diagrams of discrete data systems – System with zero-order hold – Controllability and observability of linear time invariant discrete data system–Stability tests of discrete-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 – The Relative Gain Array (RGA) – Properties and Application of RGA - Multi-loop PID Controller – Biggest Log Modulus Tuning Method – De-coupler.

UNIT - V 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**TEXT BOOKS:**

1. Stephanopoulos,G., “Chemical Process Control-An Introduction to Theory and Practice”, Prentice Hall of India, 1stEdition, 2015.
2. Sigurd Skogestad, Ian Postlethwaite, “Multivariable Feedback Control: Analysis and Design”, John Wiley and Sons, 2005, 2nd Edition.

REFERENCES:

1. Thomas E.Marlin, Process Control–Designing Processes and Control systems for

Dynamic Performance, Mc-Graw-Hill, 2000, 2nd Edition.

2. 2.Gopal,M.,“Digital Control and State Variable Methods”, Tata McGraw Hill, 4th Edition, 2017.
3. P.Albertosand A.Sala, “Multivariable Control Systems An Engineering Approach”, Springer Verlag, 1st Edition, 2004

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Develop mathematical models for discrete time systems using state variable techniques and analyze the stability of the systems. (K3)
- Construct models from input-output data by least square and recursive least square method. (K2)
- Ability to design different digital controllers to satisfy the required criterion. (K3)
- Design a multi-loop controller and multivariable controller for multi-variable systems. (K3)
- Ability to design multivariable dynamic matrix controller for industrial processes. (K4)
- Ability to case studies on future implementation on controller design. (K3)

20EEV56

SOFT COMPUTING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To learn the basic concepts of Soft Computing
- To become familiar with various techniques like neural networks, genetic algorithms and fuzzy systems.
- To integrate various soft computing techniques for complex problems

PRE-REQUISITE: Nil

UNIT - I INTRODUCTION TO SOFT COMPUTING

9

Introduction-Artificial Intelligence-Artificial Neural Networks-Fuzzy Systems-Genetic Algorithm and Evolutionary Programming-Swarm Intelligent Systems-Classification of ANNs-McCulloch and Pitts Neuron Model-Learning Rules: Hebbian and Delta- Perceptron Network-Adaline Network-Madaline Network.

UNIT - II ARTIFICIAL NEURAL NETWORKS

9

Back propagation Neural Networks - Kohonen Neural Network -Learning Vector Quantization - Hamming Neural Network - Hopfield Neural Network- Bi-directional Associative Memory - Adaptive Resonance Theory Neural Networks- Support Vector Machines - Spike Neuron Models.

UNIT - III FUZZY SYSTEMS

9

Introduction to Fuzzy Logic, Classical Sets and Fuzzy Sets - Classical Relations and Fuzzy Relations -Membership Functions -Defuzzification - Fuzzy Arithmetic and Fuzzy Measures - Fuzzy Rule Base and Approximate Reasoning - Introduction to Fuzzy Decision Making.

UNIT - IV GENETIC ALGORITHMS

9

Basic Concepts- Working Principles -Encoding- Fitness Function - Reproduction - Inheritance Operators - Cross Over - Inversion and Deletion -Mutation Operator - Bit-wise Operators - Convergence of Genetic Algorithm.

UNIT - V HYBRID SYSTEMS

9

Hybrid Systems -Neural Networks, Fuzzy Logic and Genetic -GA Based Weight Determination - LR-Type Fuzzy Numbers - Fuzzy Neuron - Fuzzy BP Architecture - Learning in Fuzzy BP- Inference by Fuzzy BP - Fuzzy ArtMap: A Brief Introduction – Soft Computing Tools - GA in Fuzzy Logic Controller Design - Fuzzy Logic Controller.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. N.P.Padhy, S.P.Simon, "Soft Computing with MATLAB Programming", Oxford University Press, 2015
2. S.N.Sivanandam , S.N.Deepa, "Principles of Soft Computing", Wiley India Pvt. Ltd., 2nd Edition, 2011
3. S.Rajasekaran, G.A.VijayalakshmiPai, "Neural Networks, Fuzzy Logic and Genetic Algorithm, Synthesis and Applications ", PHI Learning Pvt. Ltd., 2017

REFERENCES:

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, "Neuro-Fuzzy and Soft Computing", Prentice-Hall of India, 2002
2. KwangH.Lee, "First course on Fuzzy Theory and Applications", Springer, 2005
3. George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic-Theory and Applications", Prentice Hall, 1996
4. James A. Freeman and David M. Skapura, "Neural Networks Algorithms, Applications, and Programming Techniques", Addison Wesley, 2003

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the different categories of soft computing techniques (K2)
- Illustrate neural networks modeling for different applications (K3)
- Apply fuzzy design principles for solving various fuzzy problems (K3)
- Explain the different operators and phases of genetic algorithm (K2)
- Illustrate the techniques for developing hybrid fuzzy based systems (K3)
- Apply different soft computing tools to solve engineering problems (K3)

TEXT BOOKS:

1. Wadhwa, C.L., Generation, Distribution and Utilization of Electrical Energy, New Academic Science, 2011
2. Gupta, B.R., Generation of Electrical Energy, Eurasia Publishing House (P) Ltd, New Delhi, 2003.
3. S. Sivanagaraju, M. Balasubba Reddy, D. Srilatha,' Generation and Utilization of Electrical Energy', Pearson Education, 2010.

REFERENCES:

1. Dr. Uppal S.L. and Prof. S. Rao, 'Electrical Power Systems', Khanna Publishers, New Delhi, 15th Edition, 2014.
2. H.Partab, Art and Science of Utilisation of Electrical Energy", Dhanpat Rai and Co., New Delhi, 2004.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Describe the basic principles & technologies of various renewable and nonrenewable energy resource-based power generation (K2)
- Categorize different light sources and design various illumination systems for the indoor lighting schemes, factory lighting, halls, outdoor lighting schemes, flood lighting, street lighting (K4)
- Classify different methods of electric heating and electric welding in industries. (K3)
- Compute the tractive effort for the propulsion of train, name the traction motors, list the traction motor control, track equipment and collection gear. (K3)
- Describe the selection of electrical drives based on the industrial applications. (K2)
- Explain the concept of Air conditioner and refrigerator. (K2)

20EEV62	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart knowledge on the following Topics

- To learn the various types of renewable sources of energy.
- To understand the electrical machines to be used for wind energy conversion systems.
- To learn the principles of power converters used in solar PV system.
- To study the principle of power converters used in Wind system.
- To simulate the AC-DC, AC-AC Converters, Matrix Converters and PWM Inverters

PRE-REQUISITE:

Course Code: 20EE502, 20EE702

Course Name: Power Electronics, Renewable Energy Systems

UNIT - I INTRODUCTION TO RENEWABLE ENERGY SYSTEMS 9

Classification of Energy Sources — Importance of Non-conventional energy sources — Advantages and disadvantages of conventional energy sources-Environmental aspects of energy – Impacts of renewable energy generation on the environment-Qualitative study of renewable energy resources: Ocean energy, Bio-mass 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 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.

UNIT - V 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

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 Handbook”, Academic press, 2ndEdition, 4thEdition , 2017
3. Joshua Earnest, Tore Wizeliu, ‘Wind Power Plants and Project Development’, PHI Learning Pvt.Ltd, New Delhi, 2011
4. D.P.Kothari, K.C Singal, Rakesh Ranjan “Renewable Energy Sources and Emerging Technologies”, PHI Learning Pvt. Ltd, New Delhi, 2013
5. Rai.G.D, ”Solar energy utilization”, Khanna publishers, 5th Edition, 2008
6. Rai G.D., Non-Conventional Energy Sources, Khanna Publishers, 2011
7. H.Khan, "Non-conventional Energy sources", Tata McGraw-hill Publishing Company, New Delhi, 2017, 3rd Edition.
8. Gray, L.Johnson, “Wind energy system”, prentice hall of India, 2nd Edition, 2006.

REFERENCES:

1. Chetan Singh Solanki, “ Solar Photovoltaics : Fundamentals, Technologies and Applications”, PHI Learning Private Limited, New Delhi, 2011
2. Godfrey Boyle, “Renewable energy”, Open University, Oxford University Press in association with the Open University, 2004.
3. Shobh Nath Singh, ‘Non-conventional Energy resources’ Pearson Education, 2015

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Discuss the various types of renewable energy sources (K2)
- Analyze the performance of IG,PMSG,SCIG AND DFIG (K4)
- Analyze different power converters namely AC to DC,DC to DC and Ac to AC converters for renewable energy sources (K4)
- Analyze various operating modes of wind electrical generators and solar energy systems (K4)
- Analyze various operating modes of solar energy systems (K4)
- Develop maximum power point tracking algorithms (K4)

20EEV63	GRID INTEGRATION OF ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know the basic details of V2G
- To study the benefits & challenges of V2G
- To learn EV & V2G on the smart grids renewable energy systems
- To know the grid integration

PRE-REQUISITE: NIL

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.

UNIT - V 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

TEXT 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 Shahnian and Arindam Ghosh, Springer, 2015, 1st Edition.

REFERENCES:

1. ICT for Electric Vehicle Integration with the Smart Grid, Nand Kishor; Jesus Fraile-Ardanuy, IET 2020, 1st Edition.
2. Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid, Junwei Lu and Jahangir Hossain, IET 2015, 1st Edition.
3. Lance Noel · Gerardo Zarazua de Rubens Johannes Kester · Benjamin K. Sovacool, Vehicle-to-Grid A Socio-technical Transition Beyond Electric Mobility, 2019, 1st Edition.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the concepts related with V2G (K2)
- Discuss the grid connection of 3 phase V inverter (K2)
- Explain the technical, economics, business, regulatory & political challenges related with V2G (K2)
- Demonstrate the impact of EV and V2G on smart grid system (K2)
- Demonstrate the impact of EV and V2G on renewable energy system (K2)
- Explain the concept of grid integration and management of EVs (K2)

20EEV64	EMBEDDED SYSTEM FOR AUTOMOTIVE APPLICATIONS	L 2	T 0	P 2	C 3
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OBJECTIVES:

- To expose the students to the fundamentals and building of Electronic Engine Control systems.
- To teach on sensor functional components for vehicles.
- To discuss on programmable controllers for vehicles management systems.
- To teach logics of automation & communication techniques for vehicle communication.
- To introduce the infotainment system development.

PRE-REQUISITE: Nil

UNIT - I INTRODUCTION TO AUTOMOTIVE SYSTEMS 6

Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicle performance; Electronic control Unit – open-source ECU.

UNIT - II SENSORS AND ACTUATORS FOR AUTOMOTIVES 6

Review of automotive sensors – sensors interface to the ECU, Smart sensor and actuators for automotive applications

UNIT - III VEHICLE MANAGEMENT SYSTEMS 6

Energy Management system – Adaptive cruise control - anti-locking braking system – Safety and Collision Avoidance.

UNIT - IV ONBOARD DIAGONSTICS AND COMMUNICATION 6

OBD, Vehicle communication protocols - Bluetooth, CAN, LIN, FLEXRAY and MOST.

UNIT - V RECENT TRENDS 6

Navigation – Autonomous car – Role of IoT in Automotive systems.

30 PERIODS

LAB COMPONENTS: 30 PERIODS

1. Laboratory exercise: Use MATLAB SIMULINK / equivalent simulation / open source tools
 - a) Simulation study of automotive sensors and actuators components
 - b) Adaptive cruise control, Anti-Lock Braking System
 - c) CAN Connectivity in an Automotive Application using vehicle network toolbox
 - d) Interfacing a sensor used in car with microcontroller.
 - e) Establishing connection between Bluetooth module and microcontroller.
2. Assignment: AUTOSAR
3. Mini project: Battery Management system for EV batteries.

TOTAL: 30+30 = 60 PERIODS

TEXT BOOKS:

1. William B. Ribbens, "Understanding Automotive Electronics", Elseiver, 8th Edition, 2017.
2. Jurgen, R., "Automotive Electronics Hand Book", McGraw Hill, 2nd Edition, 1999.
3. L.Vlacic, M.Parent, F.Harahima, "Intelligent Vehicle Technologies", SAE International, 2001,1st Edition, 2017.

REFERENCES:

1. Ali Emedi, Mehrededsani, John M Miller, "Vehicular Electric power system - land, Sea, Air and Space Vehicles", Marcel Decker, 2004, 1st Edition.
2. Jack Erjavec, Jeff Arias, "Alternate Fuel Technology - Electric, Hybrid & Fuel Cell Vehicles", Cengage, 2012, 2nd Edition.
3. Electronic Engine Control technology – Ronald K Jurgen Chilton's guide to Fuel Injection – Ford 2nd Edition, 2004.
4. Automotive Electricals / Electronics System and Components, Tom Denton, 5th Edition, 2017.
5. Uwe Kiencke, Lars Nielsen, "Automotive Control Systems: For Engine, Drive line, and Vehicle", Springer; 1st Edition, 2005.
6. Automotive Electricals Electronics System and Components, Robert Bosch Gmbh, 5th Edition, 2014.
7. Automotive Hand Book, Robert Bosch, Bently Publishers,10th Edition, 2018.

LIST OF OPEN SOURCE SOFTWARE / LEARNING WEBSITE:

1. https://www.autosar.org/fileadmin/ABOUT/AUTOSAR_EXP_Introduction.pdf
2. <https://microcontrollerslab.com/can-communication-protocol/>
3. <https://ackodrive.com/car-guide/different-types-of-car-sensors/>
4. <https://www.tomtom.com/blog/automated-driving/what-is-adaptive-cruise-control/>
5. <https://prodigytechno.com/difference-between-lin-can-and-flexray-protocols/>
6. <https://www.synopsys.com/automotive/what-is-autonomous-car.html>

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Outline the overview of Automotive systems (K2)
- Summarize the operation of Smart sensor and actuators for automotive applications. Conduct an experiment to Simulate the automotive sensors and actuators components Using MATLAB SIMULINK / equivalent simulation / open source tools (K3)
- Explain the Embedded concepts for vehicle management and control systems. Conduct an experiment to Simulate the Adaptive cruise control, Anti-Lock Braking System Using MATLAB SIMULINK / equivalent simulation / open source tools (K3)
- Discuss the function of onboard diagnostics and Vehicle communication protocols. Conduct an experiment to Simulate the CAN Connectivity in an Automotive Application using vehicle network toolbox Using MATLAB SIMULINK / equivalent simulation / open source tools (K3)
- Describe the operation of Autonomous car and Navigation. Conduct an experiment to Interfacing a sensor used in car with microcontroller Using MATLAB SIMULINK / equivalent simulation / open source tools (K3)
- Infer the improved employability and entrepreneurship capacity due to knowledge upgradation on recent trends in embedded systems design and its application in automotive systems. Demonstrate to Establish the connection between Bluetooth module and microcontroller (K3)

REFERENCES:

1. Ashitava Ghoshal, 'Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
2. K. K.Appu Kuttan, 'Robotics', I K International, 2007.
3. Edwin Wise, 'Applied Robotics', Cengage Learning, 2003.
4. R.D.Klafter, T.A.Chimielewski and M.Negin, 'Robotic Engineering–An Integrated Approach', Prentice Hall of India, New Delhi, 1994.
5. B.K.Ghosh, 'Control in Robotics and Automation: Sensor Based Integration', Allied Publishers, Chennai, 1998.
6. S.Ghoshal, "Embedded Systems & Robotics – Projects using the 8051 Microcontroller", Cengage Learning, 2009

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain basic concept of robotics. (K2)
- Explain the kinematics of robotic system. (K2)
- Describe Instrumentation systems and their applications. (K2)
- Explain the differential motion and statics in robotics. (K2)
- Explain the various path planning techniques. (K2)
- Explain the dynamics and control in robotics industries. (K2)

REFERENCES:

1. John G. Webster, Medical Instrumentation Application and Design, John Wiley and sons, 5th Edition, 2020.
2. R.Anandanatarajan, Biomedical Instrumentation and Measurements, PHI Learning Private Limited, 2011.
3. Ed. Joseph D. Bronzino, The Biomedical Engineering Hand Book, 4th Edition, Boca Raton, CRC Press LLC, 2015.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the philosophy of the heart, lung, blood circulation and respiration system. (K2)
- Describe the concept of measurement of non-electrical parameters. (K2)
- Explain the various sensing and measurement devices of electrical origin. (K2)
- Describe the importance of electrical safety in various biomedical device. (K2)
- Explain the construction and working of imaging device and their analysis. (K2)
- Explain the working of medical assistance/techniques, robotic and therapeutic equipment's. (K2)

20EEV71	UNDER GROUND CABLE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart knowledge on the following topics

- Understanding Power Cable Characteristics and Applications.
- Cable Manufacturing.
- Installation of underground power cables
- Underground cable System Fault Locating.
- Testing and maintenance of Underground cable system.
- Cable Performance and Field Assessment of Power Cables

PRE-REQUISITE: Nil

UNIT - I INTRODUCTION TO ELECTRICAL POWER CABLES 9

Development of Underground Cables – Electric Lighting – Distribution of Energy for Lighting – Paper Insulated Cables – Underground Residential Distribution Systems – Medium Voltage Cable Development.

UNIT - II CABLE ARCHITECTURE, DIELECTRIC THEORY AND CABLE CHARACTERISTICS 9

Architecture of Underground Cabling System – Basic Dielectric Theory of Cable – Conductors – Armour and Protective Finishes – Cable Characteristics: Electrical - Fundamentals of Electrical Insulation Materials - Electrical Properties of Cable Insulating Materials - Cable Standards and Quality Assurance - Cable design parameters- Current Carrying Capacity - Short-circuit Ratings.

UNIT - III SUPPLY DISTRIBUTION SYSTEMS AND CABLES 9

Supply Distribution Systems - Distribution Cable Types, Design and Applications – Paper Insulated Distribution Cables - PVC Insulated Cables - Polymeric Insulated Distribution Cables for 6-30 kV - Manufacture of Distribution Cables - Joints and Terminations for Distribution Cables –Testing of Distribution Cables.

UNIT - IV TRANSMISSION SYSTEMS AND CABLES 9

Basic Cable Types for A.C. Transmission - Self-contained Fluid – filled Cables – Gas Pressure Cables - High Pressure Fluid-filled Pipe Cables - Polymeric Insulated Cables for Transmission Voltages – Techniques for Increasing Current Carrying Capacity – Transmission Cable Accessories and Jointing for Pressure – assisted and Polymeric Cables.

UNIT - V CABLE INSTALLATION, TESTING, MAINTENANCE 9

Installation of Transmission Cables - Splicing, Terminating, and Accessories – Sheath Bonding and Grounding - Testing of Transmission Cable Systems - Underground System Fault Locating - Field Assessment of Power Cable Systems- Condition monitoring tests —PD measurements.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. William Thue, 'Electrical Power Cable Engineering', CRC Press Taylor & Francis Group., 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL33487-2742, 3rd Edition 2017.
2. G.F.Moore, 'Electric Cables Handbook' – Third edition, Blackwell Science Ltd, 9600 Garsington Road, Oxford OX42DQ, UK., January 2017.

REFERENCES:

1. Leonard L. Grigsby, 'Electrical Power Cable Engineering' - CRC Press, Marcel Dekker, 3rd Edition 2012.
2. Christian Flytkjaer Jensen, Online Location of Faults on AC Cables in Underground Transmission Systems (Springer Theses), 2014, March.
3. K. H. Ali et al.: Industry Practice Guide for Underground Cable Fault-Finding in the LV DN: <https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9807279>, June 2022.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Describe the development of underground cable system. (K2)
- Summarize the architecture of UG cable and physical and electrical characteristics of the UG cable. (K2)
- Discuss the different types of cable used in distribution system. (K2)
- Explain the Underground cables used in transmission system (K2)
- Summarize the cable installations procedures and practices. (K2)
- Discuss the theory /methodology of cable fault detection and rectification, testing and maintenance (K2)

REFERENCES:

1. Thomas A. Lipo, Pulse Width Modulation for Power Converters: Principles and Practice, D.Grahame Holmes, John Wiley & Sons, Oct-2003, 1stEdition.
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 Multi level Inverters, Springer, 2019, 1st Edition.
4. Ersan Kabalcı, Multilevel Inverters Introduction and Emergent Topologies, Academic Press Inc, 2021,1st Edition.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Examine the different topologies of multi level inverters (MLIs) with and without DC link capacitor (K3)
- Examine the performance of MLI switch Bipolar Pulse Width Modulation (PWM) Unipolar PWM Carrier-Based PWM Schemes Phase Level Shifted Multi carrier Modulation (K3)
- Demonstrate the working principles of Cascaded H-Bridge MLI, diode clamped MLI, flying capacitor MLI and MLI with reduced switch count (K3)
- Analyze the voltage balancing performance in Diode clamped MLI. (K3)
- Simulate three level, capacitor clamed and diode clamped MLI with R and RL load (K3)
- Simulate MLI with reduced switch configuration using fundamental switching scheme (K3)

20EEV73	INTELLIGENT CONTROL OF ELECTRIC VEHICLES	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To design and drive the mathematical model of a BLDC motor and its characteristics
- To learn the different control schemes for BLDC motor
- To study the basics of fuzzy logic
- To study the FPGA & VHDL basics
- To implement fuzzy logic control of BLDC motor in real time

PRE-REQUISITE: NIL

UNIT - I MATHEMATICAL MODEL AND CHARACTERISTICS 6
ANALYSIS OF THE BLDC MOTOR

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 Transient.

UNIT - II SPEED CONTROL FOR ELECTRIC DRIVES 6

Introduction -PID Control Principle, Anti windup Controller, Intelligent Controller. Vector Control. Control applied to BLDC motor.

UNIT - III FUZZY LOGIC 6

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 6

Introduction – FPGA Architecture-Advantages-Review of FPGA family processors- Spartan 3, Spartan 6 and Spartan 7. VHDL Basics- Fundamentals-Instruction set-data type-conditional statements- programs like arithmetic, sorting, PWM generation, Speed detection.

UNIT - V REAL TIME IMPLEMENTATION 6

Inverter design, identifying rotor position via hall effect sensors, open loop and fuzzy logic control of 48 V BLDC motor using FPGA.

30 PERIODS

LAB COMPONENT:

30 PERIODS

- Design and simulate speed controller for induction motors in EV for both dynamic and steady state performance
- Simulate a fuzzy logic controller based energy storage system for EV.
- Simulate a Fuzzy logic controller for BLDC motor

TOTAL: 30+30 = 60 PERIODS

TEXT BOOKS:

1. Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, John G. Hayes, G. Abas Goodarzi, Wiley 1st Edition 2018.
2. VHDL Primer, A (3rd Edition), Jayaram Bhasker, Prentice Hall, 1st Edition 2015.
3. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Third Edition" CRC Press, Taylor & Francis Group, 2021, 1st Edition.

REFERENCES:

1. Chang-liang, Permanent Magnet Brushless DC Motor Drives and Controls, Xia Wiley 2012, 1st Edition.
2. 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.
3. Wei Liu, Hybrid Electric Vehicle System Modeling and Control, Wiley 2017, 2nd Edition
4. Electric and Plug-in Hybrid Vehicle Networks Optimization and Control, Emanuele Crisostomi, Robert Shorten, Sonja Stüdli, Fabian Wirth, CRC Press, 1st Edition. 2018.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Design the mathematical model of a BLDC motor and to discuss about its characteristics (K3)
- Demonstrate the PID control, and windup controller, Intelligent Controller and Vector Control, Control applied to BLDC motor. (K3)
- Illustrate the basics of fuzzy logic system (K2)
- Describe the basics of VHDL applied to control of EVs. (K2)
- Describe the basics of FPGA applied to control of EVs. (K2)
- Design and implement of fuzzy logic control scheme for BLDC motor using FPGA in real time. (K3)

20EEV74	VLSI DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the fundamentals of CMOS circuits and its characteristics.
- To learn the design and realization of combinational Circuits
- To gain knowledge about Sequential logic circuits.
- To educate on Architectural choices and performance tradeoffs involved in designing and realizing the circuits in CMOS technology
- To learn the different FPGA architectures and testability of VLSI circuits

PRE-REQUISITE:

Course Code: 20EE505

Course Name: Microprocessors, Microcontrollers and Applications

UNIT - I MOS TRANSISTOR PRINCIPLE 9

NMOS and PMOS transistors, Process parameters for MOS and CMOS, Electrical properties of CMOS circuits and device modeling, Scaling principles and fundamental limits, CMOS inverter scaling, propagation delays, Stick diagram, Layout diagrams.

UNIT - II COMBINATIONAL LOGIC CIRCUITS 9

Combinational Logic Design, Elmore's constant, Pass transistor Logic, Transmission gates, static and dynamic CMOS design, Power dissipation – Low power design principles.

UNIT - III SEQUENTIAL LOGIC CIRCUITS 9

Static and Dynamic Latches and Registers, Timing issues, pipelines, clock strategies, Memory architecture and memory control circuits, Low power memory circuits, Synchronous and Asynchronous design.

UNIT - IV DESIGNING ARITHMETIC BUILDING BLOCKS 9

Data path circuits, Architectures for ripple carry adders, carry look ahead adders, High speed adders, accumulators, Multipliers, dividers, Barrel shifters, speed and area tradeoff.

UNIT - V IMPLEMENTATION STRATEGIES 9

Full custom and Semi custom design, Standard cell design and cell libraries, FPGA building block architectures, FPGA interconnect routing procedures

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Jan Rabaey, Anantha Chandrakasan, B.Nikolic, "Digital Integrated Circuits: A Design Perspective", Second Edition, Prentice Hall of India, 2016.
2. N.Weste, K.Eshraghian, "Principles of CMOS VLSI Design", Second Edition, Addison Wesley 2017.

REFERENCES:

1. A.Pucknell, Kamran Eshraghian, "BASIC VLSI Design", Fourth Edition, Prentice Hall of India,2017.
2. Jacob Baker "CMOS: Circuit Design, Layout, and Simulation, Third Edition", Wiley IEEE Press 2010.
3. Sung-Mo kang, Yusuf leblebici, Chulwoo Kim "CMOS Digital Integrated Circuits: Analysis & Design",4th edition, McGraw Hill Education,2013.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the concepts of digital building blocks using MOS transistor. (K2)
- Describe combinational MOS circuits and power strategies (K2)
- Illustrate the concept of Sequential Circuits and low power memory circuits. (K2)
- Explain the arithmetic building blocks and memory subsystems (K2)
- Discuss the concept of full custom and semi custom design (K2)
- Explain the FPGA interconnect routing procedures (K2)

20EEV75	MACHINE MONITORING SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To make the students familiarize with the concept of condition-based maintenance for effective utilization of machines.
- To Impart the knowledge of artificial intelligence for machinery fault diagnosis.
- To give basic knowledge on vibration monitoring.
- To study the machinery vibrations using signal processing techniques.
- To provide knowledge on FMECA.

PRE-REQUISITE: Nil

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 planned maintenance – 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 diagnosed by vibration analysis.

UNIT- IV SIGNAL PROCESSING IN MACHINERY MONITORING 9
FFT analysis – Time domain analysis – Time-frequency analysis – Signal filtering – Cepstrum analysis – Health condition of compressor & engine.

UNIT-V 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

TEXT BOOKS:

1. Cornelius Scheffer and Paresh Girdhar, “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.

REFERENCES:

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.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Identify the faults in machinery L1. (K3)
- Choose the proper maintenance strategies and condition monitoring techniques for identification of failure in a machine L3. (K3)
- Construct a classifier model for machine learning based fault diagnosis L5. (K3)
- Predict the faulty component in a machine by analyzing the acquired vibration signals L2. (K2)
- Analyze & build a model using modern tools L4. (K4)
- Understand the concept of Machine learning (K2)

20EEV76	ENERGY STORAGE SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

Students will be able to:

- Understand the various types of energy storage Technologies.
- Analyze thermal storage system.
- Analyze different battery storage technologies
- Analyze the thermodynamics of Fuel Cell
- 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 of TRNSYS.

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 oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis – advantages and disadvantages.

UNIT-V 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

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 Xueliangsun, '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.

REFERENCES:

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.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Understand different types storage technologies (K2)
- Design a thermal storage system (K4)
- Analyze the thermodynamics of fuel cell (K4)
- Predict the faulty component in a machine by analyzing the acquired vibration signals L2. (K2)
- Analyze the appropriate storage technologies for different applications (K4)
- Explore the alternate energy storage technologies. (K3)

20EEV81	SUBSTATION ENGINEERING AND AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To help engineering students to have a holistic understanding of the concepts behind substation engineering and design.
- The course aims to give an exposure to the students to the requirements of practical aspects including an overview of civil and mechanical aspects.
- Course aims to enhance the knowledge, and give the practical guidelines for site selection, construction, protection along with maintenance, safety in a substation.
- It also aims at providing knowledge about state-of-the-art technology in substation automation system
- To help engineering students to have a holistic understanding of the concepts behind substation engineering and design.

PRE-REQUISITE: Nil

UNIT-I SUBSTATION DESIGN DEVELOPMENT 9

Substation Introduction and Classifications, Different bus bar switching schemes for Substation. Standards and Practices, Factors Influencing Substation Design - Altitude, Ambient Temperature, Earthquake and seismic zones, pollution and corrosion etc., Testing of Electrical Equipment, Concept and development of Single Line Diagram. Requirement of substation calculation.

UNIT-II SUBSTATION EQUIPMENT 9

Selection and sizing of main substation equipment: Transformer, Isolator, Circuit Breaker, surge arrestor, Instrument transformers, classification of equipment with a practical overview, and the performance parameters. Classifications of MV Switchgear and Key Design Parameters, MV/LV Switchgear construction and design of control scheme. Station Auxiliary equipment: Diesel Generator System, Basics of AC/DC Auxiliary Power System & Sizing of Aux. Transformer, DC System Components, Battery Sizing & charger Sizing, DG Set Classification, and sizing. Introduction to gas insulated substation: Operating principle of GIS, Advantage over AIS, construction of GIS

UNIT-III PROTECTION AND SUBSTATION AUTOMATION 9

Power System protection, Overcurrent and Earth Fault protection and coordination. Distribution Feeder Protection, Transformer – Unit/Main Protection, Familiarization of NUMERICAL Relays, distance/differential protection for transmission line. Substation Automation: Evolution of Substation Automation, Communication System Fundamentals-Protocol fundamental and choosing the right protocol. Substation integration and automation functional architecture, Substation signal list - DI, DO, AI, AO– Bay Control Unit (BCU), Remote Terminal Unit RTU.

UNIT- IV SUBSTATION DESIGN & LAYOUT ENGINEERING 9

Layout aspects of Outdoor Air Insulated Substation and GIS: Statutory Clearances, Equipment Layout engineering aspects for Outdoor Substation/GIS and related calculations, and guide lines, Cable routing layout, Erection Key Diagram (EKD), switchyard earthing design as per

IEEE80, Importance and Types of Earthing, Earthing Design, Types of Earthing Material, Direct stroke Lightning Protection for switchyard with IS/ IEC 62305. LV Cables - Power & Control, MV Cables, Methods for Cable Installation, Practical aspects of Cable Sizing, Cable accessories, Illumination System Design.

UNIT-V

INTERFACE ENGINEERING

9

Civil & Structural Engineering - Familiarization of site development plan, equipment supports structures, foundation for equipment, familiarization of control building and substation building, infrastructure development, Mechanical System- Fire Detection, Alarm System and Fire Suppression System for transformer, Heating, Ventilation and Air-conditioning (HVAC) for Substation

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Ibrahim Dincer and Mark A. Rosen, 'Thermal Energy Storage Systems and Applications', John Wiley & Sons, 3rd Edition, 2021.
2. Ru-shiLiu, Lei Zhang and Xueliangsun, '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.

REFERENCES:

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.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Understand the key deciding factors involved in substation design and operation. (K2)
- Know about the sizing and selection of equipment which forms part of substation (K2)
- Know about composite layout design aspects of the substation with different services and the challenges including statutory clearances. (K2)
- Understand about Interdisciplinary aspects involved in substation design (K2)
- Understand different protection and control scheme involved in substation design (K2)
- Know about substation automation system and different communication protocol involved for efficient operation of a substation (K2)

TEXT BOOKS:

1. Marian K.Kazimierczuk and Agasthya Ayachit, "Laboratory Manual for Pulse-Width Modulated DC-DC Power Converters", Wiley2016, 1stEdition.
2. Rashid M.H, "Power Electronics Circuits, Devices and Applications", Prentice Hall India, Third Edition, New Delhi, 2014 Pearson 4thedition.
3. Rashid.M.H "Power electronics Handbook", Academic press, 2ndEdition, 4thEdition, 2017
4. Feedback Control problems using MATLAB and the Control system toolbox By Dean Frederick and Joe Chow, 2000, 1stEdition, Cengage Learning.
5. Ned Mohan," Power Electronics: A First Course", Johnwiley, 2013, 1stEdition.

REFERENCES:

1. Sliding mode control for Switching Power Converters:, Techniques and Implementation, Slew-Chong Tan, Yuk Ming Lai Chi-Kong Tse, 1stEdition, 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.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Calculate transfer function for constant, differential, integral, First order and Second order factors. (K3)
- Illustrate the effect of poles and zero's in the 's' plane. (K3)
- Select Symbolic equations for solving problems related with Matrices, Polynomial and vectors. (K3)
- compute the control expression for DC–DC buck converter using sliding mode control theory (K3)
- Determine the controller expression for power factor correction circuits. (K3)
- Simulate sliding mode control of buck converter and power factor correction circuit. (K3)

20EEV83	DESIGN OF ELECTRICAL APPARATUS (20EE6A2)	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Magnetic circuit parameters and thermal rating of various types of electrical machines.
- Armature and field systems for D.C. machines.
- Core, yoke, windings and cooling systems of transformers.
- Design of stator and rotor of induction machines.
- Design of stator and rotor of synchronous machines.

PRE-REQUISITE:

Course Code: 20EE201, 20EE304, 20EE401.

Course Name: Electric Circuit Analysis, Electrical Machines-I, Electrical Machines-II.

UNIT-I DESIGN OF FIELD SYSTEM AND ARMATURE 9

Major considerations in Electrical Machine Design – Design factors-Limitations in Design- Electrical Engineering materials –Design of Magnetic circuits – Magnetizing current – Flux leakage – Leakage in Armature. Design of lap winding and wave winding.

UNIT-II DESIGN OF TRANSFORMERS 9

Construction - KVA output for single and three phase transformers – Overall dimensions design of yoke, core and winding for core and shell type transformers – Estimation of No load current – Temperature rise in Transformers – Design of Tank and cooling tubes of Transformers. Computer program: Complete Design of single phase core type transformer.

UNIT-III DESIGN OF DC MACHINES 9

Construction - Output Equations – Main Dimensions – Choice of specific loadings –Selection of number of poles – Design of Armature – Design of commutator and brushes design of field - Computer program: Design of Armature main dimensions.

UNIT- IV DESIGN OF INDUCTION MOTORS 9

Construction - Output equation of Induction motor – Main dimensions – choice of specific loadings – Design of squirrel cage rotor and wound rotor –Magnetic leakage calculations – Operating characteristics : Magnetizing current - Short circuit current – Circle diagram - Computer program: Design of slip-ring rotor

UNIT- V DESIGN OF SYNCHRONOUS MACHINES 9

Output equation – choice of specific loadings – Design of salient pole machines – Shortcircuit ratio – Armature design – Estimation of air gap length – Design of rotor –Design of damper winding – Determination of full load field MMF – Design of turbo alternators -Computer program: Design of Stator main dimensions.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Sawhney, A.K., 'A Course in Electrical Machine Design', Dhanpat Rai & Sons, New Delhi, Fifth Edition, 2016.
2. M V Deshpande 'Design and Testing of Electrical Machines' PHI learning Pvt Lt, 2011.
3. Sen, S.K., 'Principles of Electrical Machine Designs with Computer Programmes', Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2009.

REFERENCES:

1. A.Shanmugasundaram, G.Gangadharan, R.Palani 'Electrical Machine Design Data Book', New Age International Pvt. Ltd., Reprint 2007.
2. Balbir Singh, 'Electrical Machine Design', Vikas Publishing House Private Limited, 1981.
3. V Rajini, V.S Nagarajan, 'Electrical Machine Design', Pearson, 2017.
4. K.M.Vishnumurthy, 'Computer aided design of electrical machines', B S Publications, 2008.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the design considerations for rotating and static electrical machines. (K3)
- Design lap and wave winding for DC machines. (K3)
- Analyze the design parameters of single and three phase transformer. (K4)
- Design armature and field of DC machines. (K3)
- Design stator and rotor of induction motor. (K3)
- Design stator and rotor of synchronous machines. (K3)

20EEV84	MEMS AND NEMS	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To introduce the diverse technological and functional approaches of MEMS/NEMS and applications.
- To understand the microstructures and fabrication methods.
- To provide an insight of micro and nano sensors, actuators.
- To emphasis the need for NEMS technology.
- To update the ongoing trends and real time applications of MEMS and NEMS technology.

PRE-REQUISITE: Nil

UNIT - I INTRODUCTION TO MEMS and NEMS 6

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

UNIT - II MICRO-MACHINING AND MICRO FABRICATION TECHNIQUES 6

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

UNIT - III MICRO SENSORS AND MICRO ACTUATORS 6

Micro machining: Capacitive Sensors – Piezoresistive Sensors – Piezoelectric actuators.

UNIT - IV NEMS TECHNOLOGY 6

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

UNIT - V MEMS and NEMS APPLICATION 6

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

30 PERIODS

LAB COMPONENTS: 30 PERIODS

1. Laboratory experiment: Simulation of MEMS sensors and actuators using Multi physics tool
 - a) Simulation of a typical piezoresistive sensor
 - b) Simulation of a typical Piezoelectric actuator
 - c) Simulation study of a biosensor
 - d) Simulation study of a micro motor
2. Assignment: Role of MEMS and NEMS devices for Industry Standard 5.0.
3. Mini project: Design and analysis of any MEMS/NEMS device using multi physics tool.

TOTAL: 30+30 = 60 PERIODS

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 Micro engineering" (2nded.). CRC Press, 2005.
4. Julian W Gardner and Vijay K Varadan, "Micro sensors, MEMS and Smart Devices", John Wiley and Sons Ltd, 2001, 1st Edition.

REFERENCES:

1. Marc F madou "Fundamentals of micro fabrication" CRC Press 2002 2nd Edition Marc Madou.
2. M.H.Bao "Micro mechanical transducers: Pressure sensors, accelerometers and gyroscopes", Elsevier, Newyork, 16 Oct 2000,1stEdition.
3. Maluf, Nadim "An introduction to Micro Electro-mechanical Systems Engineering" AR Tech house, Boston, June 30 2004, 2nd Edition.
4. Mohamed Gad- el -Hak "MEMS Handbook" Edited CRC Press 2001,1st Edition.

LIST OF OPEN SOURCE SOFTWARE / LEARNING WEBSITE:

1. https://www.academia.edu/Lectures_on_MEMS_and_MICROSYSTEMS_DESIGN_AND_MANUFACTURE
2. <https://nptel.ac.in/courses>
3. <https://www.iitk.ac.in/me/mems-fabrication>
4. <http://mems.iiti.ac.in/>
5. https://onlinecourses.nptel.ac.in/noc22_ee36/preview

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the material properties and the significance of MEMS and NEMS for industrial automation. (K2)
- Discuss the process of micromachining and micro fabrication techniques (K2)
- Summarize the fabrication mechanism for MEMS sensor and actuators. Conduct an experiment to Simulate the piezoresistive sensor and Piezoelectric actuator using Multi physics tool (K3)
- Explain the fabrication techniques of NEMS to models, simulate and process the sensors and actuators (K2)
- Infer the improved Employability and entrepreneurship capacity due to knowledge upgradation on MEMS and NEMS technology. (K2)
- Describe the operation of biosensor, micro motor and smart sensor. Conduct an experiment to Simulate the performance of a biosensor and micro motor (K3)

20EEV85	MODEL BASED CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the Knowledge about Multivariable and Multi loop systems.
- To understand the Model predictive control schemes and its elements.
- Get exposed to state space MPC along with case studies.
- To acquire knowledge on various constrained MPC.
- To make the student understand the principles of STR, MRAC and Gain scheduling.
- To make the student design simple adaptive controllers for linear systems

PRE-REQUISITE: NIL

UNIT - I INTRODUCTION TO MIMO CONTROL 9
Introduction to MIMO Systems – Multivariable control – Multiloop Control – Multivariable MC-IMC PID – Case studies

UNIT - II MODEL PREDICTIVE CONTROL SCHEMES 9
Introduction to Model Predictive Control - Model Predictive Control Elements – Generalized Predictive Control Scheme – Multivariable Generalized Predictive Control Scheme – Multiple Model 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.

UNIT - V ADAPTIVE CONTROL SCHEME 9
Introduction to Adaptive Control - Gain Scheduling - Self tuning regulators – MARS - Adaptive Mode Predictive Control Scheme – Case Studies.

TOTAL: 45 PERIODS

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.

REFERENCES:

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. 1stEdition.

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, 1stEdition.
3. J.A. ROSSITER "Model-Based Predictive Control A Practical Approach" Taylor & Francis e-Library, 2005, 1stedition.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Ability to apply engineering knowledge to understand the control schemes on MIMO systems (K2)
- Ability to design controller for MIMO system (K3)
- Ability to analyze the control schemes available in industries (K3)
- Ability to design MPC, Adaptive controllers for practical engineering problems (K3)
- Ability to choose suitable controllers for the given problems (K2)
- Ability to apply case studies on advanced controller for future implementation. (K2)

20EEV86	PROBABILITY AND STATISTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course aims at providing the required skill to apply the statistical tools in engineering problems.
- To introduce the basic concepts of probability and random variables of one and two dimensions
- To acquaint the knowledge of testing of hypothesis for small and large samples and to introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control.

PRE-REQUISITE: Nil**UNIT - I PROBABILITY AND RANDOM VARIABLES 9**

Probability–Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Uniform, Exponential and Normal distributions.

UNIT - II TWO-DIMENSIONAL RANDOM VARIABLES 9

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT - III TESTING OF HYPOTHESIS 9

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means-Tests based on t, Chi-square and F distributions for mean, variance and proportion-Contingency table (test for independent) - Goodness of fit

UNIT - IV DESIGN OF EXPERIMENTS 9

One way and Two way classifications – Completely randomized design – Randomized block design – Latin square design - 2^2 factorial design.

UNIT - V STATISTICAL QUALITY CONTROL 9

Control charts for measurements (X and R charts) – Control charts for attributes (p,c and np charts) –Tolerance limits - Acceptance sampling

TOTAL: 45 PERIODS**TEXT BOOKS:**

1. Johnson. R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015
2. Veerarajan.T., "Probability, Statistics and Random Processes", Tata McGraw Hill, New Delhi , 2006.

REFERENCES:

1. Papoulis.A. and Unnikrishnapillai.S., "Probability, Random Variables and Stochastic Processes", McGraw Hill Education India, New Delhi, 4th Edition, 2002.
2. Spiegel.M.R., Schiller.J and Srinivasan.R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill, 3rd Edition, 2004.
3. Walpole.R.E., Myers.R.H., Myers.S.L. and Ye.K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th Edition, 2011.
4. Gupta.S.C., Kapoor.V.K., "Fundamental of Mathematical Statistics", Sultan chand & Sons Educational Publishers, New Delhi, Reprint 2013.
5. Kandasamy.P., Thilagvathi.K., Gunavathi.K., "Probability Random Variables & Random Processes", S.Chand & Co.Ltd., Reprint 2008.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Build the parameters of statistical distributions using basic probability theory concepts. (K3)
- Calculate the statistical measures for two dimensional random variables. (K3)
- Apply the concepts of testing of hypothesis for large samples. (K3)
- Apply t-test, chi-square and F- Test for small samples. (K3)
- Apply the basic concepts of design of experiments in the field of agriculture. (K3)
- Use control charts for quality control problems. (K3)

200E201	FUNDAMENTALS OF RENEWABLE ENERGY SYSTEM	L	T	P	C
		3	0	0	3

(Qualitative Treatment only)

OBJECTIVES:

To impart knowledge on the following Topics

- Awareness about renewable Energy Sources and technologies.
- Adequate inputs on a variety of issues in harnessing renewable Energy.
- Recognize current and possible future role of renewable energy sources.

PRE-REQUISITE: NIL

UNIT-I RENEWABLE ENERGY SOURCES 9

Environmental consequences of fossil fuel use - Importance of renewable sources of energy - Sustainable Design and development - Types of Renewable Energy sources - Limitations of Renewable Energy sources - Present Indian and international energy scenario of conventional and Renewable Energy sources.

UNIT-II WIND ENERGY 9

Power in the Wind – Types of Wind Power Plants (WPPs) – Components of WPPs - Working of WPPs - Siting of WPPs - Grid integration issues of WPPs.

UNIT-III SOLAR PV AND THERMAL SYSTEMS 9

Solar Radiation - Radiation Measurement - Solar Thermal Power Plant - Central Receiver Power Plants, Solar Ponds - Thermal Energy storage system with PCM - Solar Photovoltaic systems : Basic Principle of SPV conversion – Types of PV Systems - Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array, PV Module I-V Characteristics, Efficiency & Quality of the Cell, series and parallel connections, maximum power point tracking, Applications.

UNIT- IV BIOMASS ENERGY 9

Introduction - Bio mass resources – Energy from Bio mass: conversion processes - Biomass Cogeneration - Environmental Benefits. Geothermal Energy: Basics, Direct Use, Geothermal Electricity. Mini/micro hydro power: Classification of hydropower schemes, Classification of water turbine, Turbine theory, Essential components of hydroelectric system.

UNIT-V OTHER ENERGY SOURCES 9

Tidal Energy: Energy from the tides, Barrage and Non Barrage Tidal power systems. Wave Energy: Energy from waves, wave power devices. Ocean Thermal Energy Conversion (OTEC) - Hydrogen Production and Storage- Fuel cell: Principle of working - various types - construction and applications. Energy Storage System - Hybrid Energy Systems.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Joshua Earnest, Tore Wizeliu, 'Wind Power Plants and Project Development', PHI Learning Pvt. Ltd, New Delhi, 2011.
2. D.P.Kothari, K.C Singal, Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt. Ltd, New Delhi, 2013.
3. Scott Grinnell, "Renewable Energy & Sustainable Design", CENGAGE Learning, USA, 2016.

REFERENCES:

1. A.K.Mukerjee and Nivedita Thakur, 'Photovoltaic Systems: Analysis and Design', PHI Learning Private Limited, New Delhi, 2011
2. Richard A. Dunlap, 'Sustainable Energy', Cengage Learning India Private Limited, Delhi, 2015.
3. Chetan Singh Solanki, 'Solar Photovoltaics : Fundamentals, Technologies and Applications', PHI Learning Private Limited, New Delhi, 2011
4. Bradley A. Striebig, Adebayo A.Ogundipe and Maria Papadakis, 'Engineering Applications in Sustainable Design and Development', Cengage Learning India Private Limited, Delhi, 2016.
5. Godfrey Boyle, 'Renewable energy', Open University, Oxford University Press in association with the Open University, 2004.
6. Shobh Nath Singh, 'Non-conventional Energy resources' Pearson Education, 2015.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain renewable Energy Sources and technologies. (K2)
- Describe the issues in harnessing renewable Energy. (K2)
- Explain the different types of wind power plant systems. (K2)
- Describe the principle of solar PV system. (K2)
- Explain basics about biomass energy. (K2)
- Illustrate other renewable sources and its features. (K2)

200E202	PRINCIPLES OF MEASUREMENTS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

(Qualitative Treatment only)

OBJECTIVES:

To impart knowledge on the following Topics

- To introduce the basic functional elements of instrumentation.
- To introduce the fundamentals of electrical and electronic instruments.
- To educate on the comparison between various measurement techniques.
- To introduce various storage and display devices.
- To introduce various transducers and the data acquisition systems.

PRE-REQUISITE: NIL

UNIT-I INTRODUCTION 9

Functional elements of an instrument – Static and dynamic characteristics – Errors in measurement – Statistical evaluation of measurement data – Standards and calibration.

UNIT- II ELECTRICAL AND ELECTRONICS INSTRUMENTS 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 -Electrodynamometer type Wattmeter, Extension of Voltmeter and Ammeter range - Construction, working principle of Instrument transformers - 1φ Induction type Energy meter.

UNIT-III COMPARISON METHODS OF MEASUREMENTS 9

D.C potentiometers - Crompton Potentiometer, D.C (Wheatstone, Kelvin, Kelvin double) bridges & A.C (Maxwell, Anderson, Hay's, Wein & Schering) bridges.

UNIT- IV STORAGE AND DISPLAY DEVICES 9

Magnetic disk and tape – Recorders, digital plotters and printers, CRT display, digital CRO, LED, LCD & Dot matrix display – Elements of data acquisition system - Data Loggers.

UNIT-V TRANSDUCERS AND DATA ACQUISITION SYSTEMS 9

Classification of transducers – Selection of transducers – Resistive Transducer – Strain guage, Measurement of Temperature - RTD, thermistor & thermocouple, Capacitive transducer - Inductive Transducers – Linear Variable Differential Transducer (LVDT), Piezoelectric, Hall effect, optical and digital transducers

TOTAL: 45 PERIODS

TEXT BOOKS:

1. A.K. Sawhney, 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2017.
2. J. B. Gupta, 'A Course in Electronic and Electrical Measurements', S. K. Kataria & Sons, Delhi, 2018.
3. H.S. Kalsi, 'Electronic Instrumentation', McGraw Hill, 4th Edition 2019.

REFERENCES:

1. E.O. Doebelin, Dhanesh N Manik, 'Measurement Systems', 7th Edition, McGraw Hill publishing company, 2019.
2. R.K. Rajput, 'Electrical and Electronics Measurements and Instrumentation', S. Chand Publications, New Delhi, 4th Edition, 2016.
3. Alan. S. Morris, 'Measurement and Instrumentation: Theory and Application', Prentice Hall of India, 2nd Edition, 2015.
4. David Bell, 'Electronic Instrumentation & Measurements', Oxford University Press, 2013.
5. D.V.S. Murthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2015

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the characteristics of measuring Instruments systems. (K2)
- Explain the concepts of fundamentals of MC and MI Instruments (K2)
- Discuss various electrical and electronic measuring instruments, their construction, working principle and applications. (K2)
- Classify AC and DC bridges and formulate balance equation to calculate unknown resistance, inductance and capacitance. (K2)
- Explain the various storage and display devices. (K2)
- Explain the construction and working of various types of transducer. (K2)

20OE203	INTRODUCTION TO NANOSCIENCE (Qualitative Treatment only)	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn about basis of nano material science
- To understand preparation method
- To explain various types and application.

PRE-REQUISITE: NIL

UNIT-I INTRODUCTION 8

Nano scale Science and Technology - Implications for Physics, Chemistry, Biology and Engineering - Classifications of nano structured materials - nano particles - quantum dots, nano wires - ultra-thin films - multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study.

UNIT- II GENERAL METHODS OF PREPARATION 9

Bottom-up Synthesis - Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT-III NANOMATERIALS 12

Nano forms of Carbon - Buckminster fullerene - graphene and carbon nano tube, Single wall carbon Nano tubes (SWCNT) and Multi wall carbon nano tubes (MWCNT) - methods of synthesis (arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications - Nano metal oxides-ZnO, TiO₂, MgO, ZrO₂, NiO, nano alumina, CaO, AgTiO₂, Ferrites, Nano clays - functionalization and applications - Quantum wires, Quantum dots-preparation, properties and applications.

UNIT- IV CHARACTERIZATION TECHNIQUES 9

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS - Nano indentation.

UNIT-V APPLICATIONS 7

Nano InfoTech: Information storage - nano computer, molecular switch, super chip, nano crystal, Nano biotechlogy: nano probes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bio imaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS) - Nano sensors, nano crystalline silver for bacterial inhibition, Nano particles for sun barrier products - In Photostat, printing, solar cell, battery.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. A.S. Edelstein and R.C. Cammearata, eds., "Nano materials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2. N John Dinardo, "Nano scale Charecterisation of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.

REFERENCES:

1. G Timp, "Nanotechnology", AIP press/Springer, 1999.
2. Akhlesh Lakhtakia, "The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations". Prentice-Hall of India (P) Ltd, New Delhi, 2007.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the concepts of Nano science. (K2)
- Describe the process involved in the preparation of Nano materials. (K2)
- Illustrate the methods of synthesis of Nano materials. (K2)
- Describe the characteristics of Nano materials. (K2)
- Explain the applications of Nano materials. (K2)
- Describe Micro Electro Mechanical Systems (MEMS). (K2)

TEXT BOOKS:

1. K.Venkataratnam, 'Special Electrical Machines', Universities Press (India) Private Limited, 2008.
2. T. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 2009
3. E.G. Janardanan, 'Special electrical machines', PHI learning Private Limited, Delhi, 2014.

REFERENCES:

1. Miller T J E, 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press, Oxford, 2008.
2. Kenjo T and Nagamori S, 'Permanent Magnet and Brushless DC Motors', Clarendon Press, London, 1986.
3. R. Krishnan, 'Switched Reluctance Motor Drives - Modeling, Simulation, Analysis, Design and Application', CRC Press, New York, 2014.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Describe the performance characteristics of stepper motor and examine the closed loop operation. (K2)
- Describe torque prediction of stepper motor from the fundamental principle. (K2)
- Explain the characteristics of switched reluctance motor and design the closed loop control of SRM for suitable applications. (K2)
- Explain the principle of operation of permanent magnet brushless DC motor and compute EMF and torque equation. (K2)
- Discuss the power controller circuit of permanent magnet synchronous motor to enhance the performance characteristics. (K2)
- Explain the performance of synchronous reluctance motor and compute the voltage and torque equation. (K2)

20OE205	INDUSTRIAL ENERGY AUDITING AND MANAGEMENT	L	T	P	C
		3	0	0	3

(Qualitative Treatment only)

OBJECTIVES: To impart knowledge on the following Topics

- Awareness about importance of energy management and auditing..
- Understanding the Energy management on various electrical motors.
- Understanding the Energy management on electric lighting systems.
- Apply the different types of metering methods of energy management and auditing
- Provide the economic models for energy and load management.

PRE-REQUISITE: NIL

UNIT - I INTRODUCTION 9

Basics of Energy – Need for energy management – Energy accounting – Energy monitoring, targeting and reporting – Energy audit process.

UNIT - II ENERGY MANAGEMENT FOR MOTORS AND COGENERATION 9

Energy management for electric motors – Transformer and reactors – Capacitors and synchronous machines, energy management by cogeneration – Forms of cogeneration – Feasibility of cogeneration – Electrical interconnection.

UNIT - III LIGHTING SYSTEMS 9

Energy management in lighting systems – Task and the working space – Light sources – Ballasts – Lighting controls – Optimizing lighting energy – Power factor and effect of harmonics, lighting and energy standards..

UNIT - IV METERING FOR ENERGY MANAGEMENT 9

Metering for energy management – Units of measure – Utility meters – Demand meters – Paralleling of current transformers – Instrument transformer burdens – Multi tasking solid state meters, metering location vs requirements, metering techniques and practical examples.

UNIT - V ECONOMIC ANALYSIS AND MODELS 9

Economic analysis – Economic models – Time value of money – Utility rate structures – Cost of electricity – Loss evaluation, load management – Demand control techniques – Utility monitoring and control system – HVAC and energy management – Economic justification.

TOTAL: 45PERIODS

TEXT BOOKS:

1. Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, Guide to Energy Management, Fifth Edition, The Fairmont Press, Inc., 2006
2. Eastop T. D & Croft D. R, Energy Efficiency for Engineers and Technologists, Logman Scientific & Technical, ISBN-0-582-03184, 1990.

REFERENCES:

5. Reay D.A, Industrial Energy Conservation, 1st edition, Pergamon Press, 1977.
6. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.
7. Amit K. Tyagi, Handbook on Energy Audits and Management, TERI, 2003.
8. Electricity in buildings good practice guide, McGraw-Hill Education, 2016.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the importance of energy management and auditing.(K2)
- Describe energy management on different types of electrical equipment. (K2)
- Explain the Forms and feasibility of cogeneration (K2)
- Discuss the energy management on different types of lighting system and light sources. (K2)
- Describe the different types of metering methods of energy management and auditing. (K2)
- Explain the economic models for energy and load management. (K2)

20OE206	FUNDAMENTALS OF FIBRE OPTICS AND LASERS	L	T	P	C
	(Qualitative Treatment only)	3	0	0	3

OBJECTIVES:

- To expose the students to the basic concepts of optical fibres and their properties.
- To provide adequate knowledge about the Industrial applications of optical fibres.
- To expose the students to the Laser fundamentals.
- To provide adequate knowledge about Industrial application of lasers.
- To provide adequate knowledge about holography and Medical applications of Lasers.

PRE-REQUISITE: NIL**UNIT - I OPTICAL FIBRES AND THEIR PROPERTIES 9**

Construction of optical fiber cable: Guiding mechanism in optical fiber and Basic component of optical fiber communication, –Principles of light propagation through a fibre: Total internal reflection, Acceptance angle (θ_a), Numerical aperture and Skew mode – Different types of fibres and their properties: Single and multimode fibers and Step index and graded index fibers – fibre characteristics: Mechanical characteristics and Transmission characteristics, – Absorption losses – Scattering losses– Dispersion – Connectors and splicers – Fibre termination – Optical sources: Light Emitting Diode(LED) – Optical detectors: PIN Diode.

UNIT - II INDUSTRIAL APPLICATION OF OPTICAL FIBRES 9

Fibre optic sensors: Types of fiber optics sensor, Intrinsic sensor- Temperature/ Pressure sensor, Extrinsic sensors, Phase Modulated Fibre Optic Sensor and Displacement sensor (Extrinsic Sensor) – Fibre optic instrumentation system: Measurement of attenuation (by cut back method), Optical domain reflectometers, Fiber Scattering loss Measurement, Fiber Absorption Measurement, Fiber dispersion measurements, End reflection method and Near field scanning techniques – Different types of modulators: Electro-optic modulator (EOM) – Interferometric method of measurement of length –Moire fringes – Measurement of pressure, temperature, current, voltage, liquid level and strain.

UNIT - III LASER FUNDAMENTALS 9

Fundamental characteristics of lasers – Level Lasers: Two-Level Laser, Three Level Laser, Quasi Three and four level lasers – Properties of laser: Monochromaticity, Coherence, Divergence and Directionality and Brightness – Laser modes – Resonator configuration – Q-switching and mode locking – Cavity damping – Types of lasers – Gas lasers, solid lasers, liquid lasers and semiconductor lasers.

UNIT - IV INDUSTRIAL APPLICATION OF LASERS**9**

Laser for measurement of distance, Laser for measurement of length, Laser for measurement of velocity, Laser for measurement of acceleration, Laser for measurement of current, voltage and Laser for measurement of Atmospheric Effect: Types of LIDAR, Construction And Working, and LIDAR Applications – Material processing: Laser instrumentation for material processing, Powder Feeder, Laser Heating, Laser Welding, Laser Melting, Conduction Limited Melting and Key Hole Melting –Laser trimming of material: Process Of Laser Trimming, Types Of Trim, Construction And Working Advantages – Material Removal and vaporization: Process Of Material Removal.

UNIT - V HOLOGRAM AND MEDICAL APPLICATIONS**9**

Holography: Basic Principle, Holography vs. photography, Principle Of Hologram Recording, Condition For Recording A Hologram, Reconstructing and viewing the holographic image– Holography for non-destructive testing – Holographic components – Medical applications of lasers, laser-Tissue Interactions Photochemical reactions, Thermalisation, collisional relaxation, Types of Interactions and Selecting an Interaction Mechanism – Laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynaecology and oncology.

TOTAL: 45 PERIODS**TEXT BOOKS:**

1. J.M. Senior, 'Optical Fibre Communication – Principles and Practice', Prentice Hall of India, January 2014.
2. Eric Udd, William B., and Spillman, Jr., "Fiber Optic Sensors: An Introduction for Engineers and Scientists ", John Wiley & Sons, 2011.
3. J. Wilson and J.F.B. Hawkes, 'Introduction to Opto Electronics', Prentice Hall of India, 2001.

REFERENCES:

1. G. Keiser, 'Optical Fibre Communication', McGraw Hill, 1995.
2. M. Arumugam, 'Optical Fibre Communication and Sensors', Anuradha Agencies, 2002.
3. John F. Ready, "Industrial Applications of Lasers", Academic Press, Digitized in 2008.
4. Monte Ross, 'Laser Applications', McGraw Hill, 1968.
5. John and Harry, "Industrial lasers and their application", McGraw-Hill, 2002.
6. Keiser, G., "Optical Fiber Communication", McGraw-Hill, 3rd Edition, 2000.

<http://nptel.ac.in/courses/117101002>

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the principle, transmission, dispersion and attenuation characteristics of optical fibers (K2)
- Explain the principle of Fibre Optical sources and Optical detectors. (K2)
- Describe the Fiber Scattering loss Measurement, Fiber Absorption Measurement and Fiber dispersion measurements (K2)
- Summarize the Fundamental characteristics and types of lasers (K2)
- Discuss the Construction and Working of industrial application of lasers (K2)
- Explain the Basic Principle of Hologram and medical applications of laser. (K2)

20OE207	ELECTRIC POWER QUALITY	L	T	P	C
	(Qualitative Treatment only)	3	0	0	3

OBJECTIVES:

- To understand the various power quality issues.
- To understand the causes, impacts and mitigation of Voltage sag and interruptions in power system.
- To understand the causes, impacts and mitigation of over voltages in power system with PSCAD and EMTP.
- To understand the concept of harmonics in power system with their causes, effects and control techniques.
- To understand the various types of conventional and modern power quality monitoring devices/methods.

PRE-REQUISITE: NIL

UNIT - I INTRODUCTION 9

Terms and definitions – Overloading – Under voltage – Sustained interruption - Sags and Swells – Waveform distortion – Total Harmonic Distortion (THD) – Computer Business Equipment Manufacturers Associations (CBEMA) curve.

UNIT - II VOLTAGE SAGS AND INTERRUPTIONS 9

Sources of sags and interruptions – Estimating voltage sag performance – Motor starting sags – Estimating the sag severity – Mitigation of voltage sags – Active series compensators – Static transfer switches and fast transfer switches.

UNIT - III OVERVOLTAGES 9

Sources of over voltages – Capacitor switching – Lightning – Ferro resonance – Mitigation of voltage swells – Surge arresters – Low pass filters – Power conditioners – Lightning protection – Shielding – Line arresters – Protection of transformers and cables – Computer analysis tools for transients – PSCAD and EMTP.

UNIT - IV HARMONICS 9

Harmonic distortion – Voltage and current distortion – Harmonic indices – Harmonic sources from commercial and industrial loads – Locating harmonic sources – Power system response characteristics – Resonance – Harmonic distortion evaluation – Devices for controlling harmonic distortion – Passive filters – Active filters – IEEE and IEC standards.

UNIT - V POWER QUALITY MONITORING AND CUSTOM POWER DEVICES 9

Power line disturbance analyzer - Harmonic/Spectrum analyzer - Flicker meters - Rectifier supported DVR – DC Capacitor supported DVR – DVR Structure – voltage Restoration –Series Active Filter – Unified power quality conditioner.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. R.C. Duggan , “Power Quality”, McGraw-Hill Education, 2012.(2nd edition)
2. A.J. Arrillaga, “Power system harmonics”, Wiley, 2003 (2nd edition)

REFERENCES:

1. G.T.Heydt, “Electric Power Quality”, Stars in a Circle Publications, 1994 (2nd edition)
2. Derek A. Paice, “Power Electronic Converter Harmonics”, Wiley-IEEE Press-1st Edition-1999

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain power quality disturbances, their causes, detrimental effects and Power quality standard. (K2)
- Describe the impact of voltage sag and interruptions in power systems. (K2)
- Analyze the over voltage phenomena using PSCAD and EMTP. (K2)
- Describe the impact of Harmonics in power systems. (K2)
- Explain the different types of monitoring devices/methods for power quality in power system. (K2)
- Discuss the different types of custom power devices for enhancement of power quality in power system. (K2)

UNIT - V DIGITAL CONTROL OF DC DRIVE**9**

Phase Locked Loop and micro-computer control of DC drives–Program flow chart for constant constant torque and constant horse power operations Speed detection and current sensing circuits and feedback elements.

TOTAL: 45 PERIODS**TEXT BOOKS:**

1. Gopal K.Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, Second Edition, 2015.
2. Krishnan R., “ Electric Motor & Drives: Modelling, Analysis and Control”, Pearson Education, 2015

REFERENCES:

1. Bin Wu, High-Power Converters and AC Drives, Wiley-IEEE Press
2. Bimal K Bose, “Modern Power Electronics and AC Drives” Pearson Education, 2016.
3. R. Krishnan, Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design, and Applications, CRC press, 2001.
4. Werner Leonhard, Control of Electrical Drives, 3rd Edition, Springer, Sept., 2001.
5. R. Krishnan, Permanent Magnet Synchronous and Brushless DC Motor Drives, CRC press, 2001.
6. Murphy, J.M.D, Turnbull F.G, Thyristor control of AC motors, Pergamon press, Oxford, 1988

OUTCOMES:**AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:**

- Explain the various control strategies and controllers for DC Motor Drive systems. (K2)
- Discuss the various control strategies and controllers for Induction Motor Drive systems and develop the closed loop operation of V/f control of Induction motor drive systems. (K2)
- Describe the various control strategies and controllers for Synchronous Motor Drive systems. (K2)
- Explain the various control strategies and controllers for SRM Motor Drive systems. (K2)
- Discuss the various control strategies and controllers for BLDC Motor Drive systems. (K2)
- Explain the various Digital control for DC Motor Drive systems. (K2)

20HS5A1	MANAGEMENT CONCEPTS & ORGANIZATIONAL BEHAVIOR	L	T	P	C
		3	0	0	3

OBJECTIVES:

To enable the students to study the evolution of Management, to study the functions and principles of management and to learn the application of the principles in an organization with a perspective to diagnose and effectively handle human behavior.

PRE-REQUISITE:NIL

UNIT-I INTRODUCTION TO MANAGEMENT 9

Origin - Definition of management -Nature & Characteristics of management - Scope of management - Importance of Management - Difference between administration & management-Levels of management -Functions of Management - Principles of management - Management by objectives - Management by exception .

UNIT-II PLANNINGAND ORGANIZING 9

Definitions of planning -Nature of planning - Importance of planning - Limitations of planning - Process / steps of planning -Elements of planning - Decision making - Characteristics of decision making - Process / steps of decision making-Nature of Organisation-Principles of Organisation - Advantages of Organisation - Process / steps of Organisation - Formal & Informal Organisation - Organisational Structure (Types) - Organisation chart - delegation - Process / steps of delegation - Centralisation - De-Centralisation

UNIT - III CO-ORDINATION AND CONTROLLING 9

Definition of Co-ordination - characteristics of Co-ordination - Benefits of Co-ordination - Problems in Coordination -Techniques of Co-ordination - Definition of controlling -characteristics of control function – Control process –Communication - Characteristics of Communication - Process of Communication - Formal & Informal Communication - Upward & Downward Communication - Sideward Communication – Written Communication -Barriers in

UNIT - IV INDIVIDUAL BEHAVIOUR 9

Meaning of Organizational behavior, contributing disciplines, importance of organizational behavior, Perception and Learning - Personality and Individual Differences - Motivation theories and Job Performance - Values, Attitudes and Beliefs - Communication Types-Process - Barriers - Making Communication Effective.

UNIT - V GROUP BEHAVIOUR 9

Groups and Teams: Definition, Difference between groups and teams, Stages of Group Development, Group Cohesiveness, Types of teams, Group Dynamics - Leadership - Styles - Approaches - Power and Politics .

TOTAL: 45 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

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

1. Explain Management principles into management practices and Managers manage business in global context with different strategies and to determine the effective ways of controlling, and decision making.(K2)
2. Understand and explain all the managerial functions. .(K2)
3. Demonstrate the applicability of the concept of organizational behavior to understand the behavior of people in the organization and management of individual behavior in the organization. .(K2)
4. Analyze the complexities associated with management of the group behavior in the organization. .(K2)
5. Demonstrate how the organizational behavior can integrate in understanding the motivation (why) behind behavior of people in the organization. .(K2)
6. Managerial functions like planning, organizing, staffing, leading & controlling and have same basic knowledge on international aspect of management and the degree to which one can make an individual to think beyond self. .(K2)

REFERENCES:

1. Stephen P. Robins, Organizational Behavior, Pearson Education, Edition 16, 2022.
2. Steven L. Mc Shane, Mary Ann Von Glinow, et al. Organizational Behavior, Edition 9, 2022
3. PC Tripathi, PN Reddy, Ashish Bajpai, Principles of Management, Tata McGraw Hill,

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Compare industrial vs consumer marketing and the classifications of industrial customers. (K2)
- Develop Negotiation and buying techniques for industrial products. (K2)
- Formulate strategic plan and implementation methods. (K2)
- Develop techniques of Logistics, Marketing Control and Channel Optimization.(K2)
- Identify Pricing tactics and Sales Force Planning techniques.(K2)
- Manage the entire industrial marketing process.(K3)

REFERENCES:

1. Industrial Marketing: A Process of Creating and Maintaining Exchange by krishnamacharyulu Csg,Lalitha R, Publisher: Jaico Book House,
2. Industrial Marketing by Ghosh, Publisher: Oxford University Press,2019
3. Industrial Marketing 2e by K. K. Havaldar, Publisher: Tata McGraw-Hill Publishing Company limited,2016
4. Industrial Marketing Management by Govindarajan, Vikas Publishing House.2018
5. Industrial Marketing by Phadtare -M. T, Prentice Hall of India Private Limited ,2020

20HS6B1	PROJECT MANAGEMENT AND ENTREPRENEURSHIP	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To make them understand the concepts of project management for planning to execution of projects.
- To develop and strengthen entrepreneurial quality and motivation in students and to impart basic entrepreneurial skills and understanding to run a business efficiently and effectively.

PRE-REQUISITE: NIL

UNIT - I PROJECT MANAGEMENT 9

Project management: meaning, scope & importance, role of project manager - Project life-cycle and Project appraisal - project feasibility report- Technical appraisal, Environmental appraisal, Market appraisal and Managerial appraisal.

UNIT - II PROJECT FINANCING 9

Project cost estimation & working capital requirements - sources of funds - capital budgeting - Risk & uncertainty in project evaluation - preparation of projected financial statements viz. Projected balance sheet - projected income statement - projected funds & cash flow statements - Preparation of detailed project report - Project finance.

UNIT - III ENTREPRENEURSHIP 9

Entrepreneurship need and scope - Entrepreneurial competencies and traits - Factors affecting entrepreneurial development - Entrepreneurial motivation (Mc Clelland's Achievement motivation theory) - conceptual model of entrepreneurship - entrepreneur vs. intrapreneur - Classification of entrepreneurs - Entrepreneurial Development Programmes.

UNIT - IV ENTREPRENEURIAL IDEA AND INNOVATION 9

Introduction to Innovation - Entrepreneurial Idea Generation and Identifying Business Opportunities - Management skills for Entrepreneurs and managing for Value Creation - Creating and Sustaining Enterprising Model - Organizational Effectiveness.

UNIT - V SOCIAL ENTREPRENEURSHIP 9

Social Sector Perspectives and Social Entrepreneurship - Social Entrepreneurship Opportunities and Successful Models - Social Innovations and Sustainability - Marketing Management for Social Ventures - Risk Management in Social Enterprises - Legal Framework for Social Ventures.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Robert D. Hisrich, Michael P. Peters and Dean A. Shepherd, "Entrepreneurship", McGraw Hill Education, Tenth Edition, 2018.
2. Peter F. Drucker, "Innovation and Entrepreneurship", Harper Business, 2006.

REFERENCES:

1. Anil K. Gupta, "Grassroots Innovation: Minds on the Margin Are Not Marginal Minds", Random House, 2016.
2. V.S.P.Rao, "Business, Entrepreneurship and Management", Vikas Publishing, 2014.
3. Rajeev Roy, "Entrepreneurship", Oxford University Press, 2011.
4. Roman Pichler, "Agile Product Management with Scrum Creating Products That Customers Love", Pearson India, 2013.
5. John M. Nicholas and Herman Steyn, "Project Management for Engineering, Business and Technology", A Butterworth-Heinemann Title, Fourth Edition, 2011

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Conclude the project characteristics and various stages of a project. (K6)
- Compile the conceptual clarity about project organization and feasibility. (K5)
- Apply the risk management plan and analyze the role of stakeholders. (K3)
- Analyze the social responsibility for an entrepreneurship. (K4)
- Interpret the gain knowledge to overcome the factors affecting small-scale business. (K3)
- Formulate a new small-scale business. (K6)

20HS6A1	INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To get an adequate knowledge on patent and copyright for their innovative research works.
- To use in their career, information in patent documents provide useful insight on novelty of their idea from state-of-the art search. This provide further way for developing their idea or innovations.
- To pave the way to catch up Intellectual Property (IP) as a career option.
 - R & D IP Counsel
 - Government Jobs – Patent Examiner
 - Private Jobs
 - Patent agent and Trademark agent

PRE-REQUISITE: NIL

UNIT - I OVERVIEW OF INTELLECTUAL PROPERTY 9

Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design - Genetic Resources and Traditional Knowledge - Trade Secret - IPR in India: Genesis and development - IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention - 1883, the Berne Convention - 1886, the Universal Copyright Convention - 1952, the WIPO Convention - 1967, the Patent Co-operation Treaty - 1970, the TRIPS Agreement - 1994.

UNIT - II PATENTS 9

Patents - Elements of Patentability: Novelty, Non Obviousness (Inventive Steps), Industrial Application - Non-Patentable Subject Matter - Registration Procedure - Rights and Duties of Patentee - Assignment and license - Restoration of lapsed Patents - Surrender and Revocation of Patents - Infringement - Remedies & Penalties - Patent office and Appellate Board.

UNIT - III COPYRIGHTS 9

Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works - cinematograph films and sound recordings - Registration Procedure - Term of protection - Ownership of copyright - Assignment and license of copyright - Infringement - Remedies & Penalties - Related Rights - Distinction between related rights and copyrights.

UNIT - IV TRADEMARKS 9

Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademarks registry and appellate board.

UNIT - V OTHER FORMS OF IP & REGISTRATION PROCESS 9

Design: meaning and concept of novel and original - Procedure for registration, effect of registration and term of protection. Geographical Indication (GI): meaning, and difference between GI and trademarks - Procedure for registration, effect of registration and term of protection. IPR registration process through government website-modalities and publications. Plant Variety Protection: meaning and benefit sharing and farmers' rights – Procedure for registration, effect of registration and term of protection. Layout Design Protection: meaning – Procedure for registration, effect of registration and term of protection.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. K.V.Nithyananda, "Intellectual Property Rights: Protection and Management", Cengage Learning India Pvt. Ltd., 2019.
2. P.Neeraj and D.Khusdeep, "Intellectual Property Rights", PHI Learning Pvt. Ltd., 2014.

REFERENCES:

1. V.K.Ahuja, "Law Relating to Intellectual Property Rights", Lexis Nexis, Third Edition, 2017.
2. Journal of Intellectual Property Rights (JIPR): NISCAIR
3. Cell for IPR Promotion and Management (<http://cipam.gov.in/>)
4. World Intellectual Property Organization (<https://www.wipo.int/about-ip/en/>)
5. Office of the Controller General of Patents, Designs & Trademarks (<http://www.ipindia.nic.in/>)

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain the fundamental aspects of Intellectual property Rights which plays a major role in development and management of innovative projects in industries. (K2)
- Describe the patents, patent regime in India and abroad and registration aspects. (K2)
- Describe the copyrights and its related rights and registration aspects. (K2)
- Explain the trademarks and registration aspects. (K2)
- Explain the Design, Geographical Indication (GI), Plant Variety and Layout Design Protection and their registration aspects. (K2)
- Analyze the current trends in IPR and Government steps in fostering IPR. (K2)

20HS7A2	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand TQM Concepts and importance of customers.
- To know about TQM Principles, understand about employee involvement and supplier partnership.
- To understand six sigma, Traditional tools, New tools, Benchmarking and FMEA.
- To understand Control charts, Taguchi Quality Loss function, QFD, TPM and Performance measures.
- To understand the various elements of Quality Management System and Environment Management System.

PREREQUISITE: NIL

UNIT - I INTRODUCTION 9

Quality – Need, Evolution, Definitions, Dimensions of product and service quality. TQM - Basic concepts, Framework, Contributions of Deming, Juran and Crosby, Barriers. Quality statements, Customer satisfaction, Customer complaints, Customer retention, Costs of quality

UNIT - II TQM PRINCIPLES 9

Strategic quality planning, Quality Councils, Employee involvement, Motivation, Empowerment, Teamwork, Quality circles, Recognition and Reward, Performance appraisal, Continuous process improvement - PDCA cycle, 5S, Kaizen, Supplier partnership, Supplier selection, Supplier Rating.

UNIT - III TQM TOOLS AND TECHNIQUES I 9

Traditional tools of quality, New management tools. Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT, Bench marking, Reason to bench mark, Bench marking process, FMEA - Stages, Types.

UNIT - IV TQM TOOLS AND TECHNIQUES II 9

Control Charts, Process Capability, Quality Function Development (QFD), Taguchi quality loss function, TPM - Concepts, improvement needs, Performance measures.

UNIT - V QUALITY SYSTEMS 9

Need for ISO 9000, ISO 9001-2008 Quality System, Elements, Documentation, Quality Auditing, QS 9000 - ISO 14000, Concepts, Requirements and Benefits, TQM Implementation in manufacturing and service sectors

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Dale H. Besterfield, et al., "Total quality Management", Pearson Education Asia, 5th Edition, 2018.
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", Cengage Learning, 8th Edition, 2012.
3. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2nd Edition, 2006.

REFERENCES:

1. Joel.E. Ross, "Total Quality Management – Text and Cases", CRC Press, 5th Edition, 2017.
2. Kiran.D.R, "Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 1st Edition, 2016.

3. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 2012.
4. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 1st Edition, 2006.
5. Brue G, "Six Sigma for Managers", Tata-McGraw Hill, 2nd Edition, 2002.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Explain basic concepts, TQM framework, Barriers Benefits of TQM and importance of customers (k2)
- Explain the TQM Principles, understand the importance of employee involvement and supplier partnership (k2)
- Explain the basics of Six Sigma, Traditional tools, New tools , (k2)
- Explain the process of Benchmarking and FMEA. (k2)
- Explain process capability, QFD, TPM, Taguchi quality loss function and performance measures (k2)
- Explain the Quality system ISO 9000, ISO 14000, Audit, Certification process and implementation of TQM in manufacturing and service sectors (k2)

20HS8A1	HUMAN RELATIONS AT WORK	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To create awareness of human relations at work its relationship with self.
- To create awareness about the processes involved in interaction with people at work.
- To understand the importance of psychological and physical health in maintaining human relations at work and progressing in career.

PRE-REQUISITE : NIL

UNIT-I INTRODUCTION TO HUMAN RELATIONS 9

Understanding and Managing Yourself – Human Relations and You – Self-Esteem and Self – Confidence – Self-Motivation and Goal Setting – Emotional Intelligence – Attitudes and Happiness – Values and Ethics – Problem Solving and Creativity.

UNIT-II HUMAN RELATIONS AT WORK 9

Dealing Effectively with People – Communication in the Workplace – Specialized Tactics for Getting Along with Others in the Workplace – Managing Conflict – Becoming an Effective Leader – Motivating Others and Developing Teamwork – Diversity and Cross-Cultural Competence.

UNIT - III STAYING PHYSICALLY HEALTHY 9

Yoga: Ashtanga, Yam and Niyam, Asan – Pranayam – Exercise: Aerobic and anaerobic.

UNIT - IV STAYING PSYCHOLOGICALLY HEALTHY 9

Managing Stress and Personal Problems – Meditation – Cognitive, behavioural and emotional well-being.

UNIT - V DEVELOPING CAREER THRUST 9

Getting Ahead in Your Career – Learning Strategies – Perception – Life Span Changes – Developing Good Work Habits.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Andrew DuBrin, "Human Relations for Career and Personal Success: Concepts, Applications, and Skills", Pearson Education, Eleventh Edition, 2016.
2. Swami Vivekananda, "Raja-Yoga or Conquering the Internal Nature", Vedanta Press, 1998.

REFERENCES:

1. Jerrold S. Greenberg, "Comprehensive Stress Management", McGraw-Hill Humanities Social, Thirteenth Edition, 2012.
2. Y.Udai, "Yogasan aur pranayama", N.S. Publications, New Delhi, 2015.
Janardan Swami Yogabhyasi Mandal, "Yogic Asanas for Group Training - Part-I", Nagpur.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Implement the elements of Emotional Intelligence and create a plan for continual improvement. (K3)
- Demonstrate the elements of teamwork such as team development stages, leadership skills, team dynamics, problems solving and decision making approaches, and team building. (K3)
- Employ active listening skills including paraphrasing, questioning, empathetic listening, analytic listening, responding and communicating non-verbally while respecting individual differences. (K3)
- Identify various Yoga Postures. (K3)
- Develop an action plan to increase personal motivation in a personal and or workplace situation. (K3)
- Identify different elements of organizational behavior and change including organizational climate, culture, power, ethics, and organizational development techniques to develop a change model for an aspect of their personal and or professional life. (K3)

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OBJECTIVES:

- To understand the fundamental economic concepts
- To understand cost estimation concepts
- To understand value engineering
- To understand project appraisal and methods of analysis
- To understand the methods of depreciation

PRE-REQUISITE: NIL

UNIT - I INTRODUCTION TO ECONOMICS 9

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics – Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis - V ratio, Elementary economic Analysis – Material selection for product Design selection of a product, Process planning.

UNIT - II COST ESTIMATION AND MACRO ECONOMICS 9

Cost and revenue concepts- Determination of equilibrium price under perfect competition - Banking – Inflation - National Income

UNIT - III VALUE ENGINEERING 9

Make or buy decision, Value engineering – Function, aims, Value engineering procedure: Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor - Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

UNIT - IV PROJECT APPRAISAL AND ANALYSIS 9

Methods of comparison of alternatives – present worth method (Revenue dominated cashflow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram),rate of return method, Examples in all the methods.

UNIT - V DEPRECIATION 9

Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives- introduction, Examples, Inflation adjusted decisions –procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.

TOTAL: 45 PERIODS

TEXT BOOK:

1. Panneer Selvam, R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi,2001.

REFERENCES:

1. ChanS.Park, "Contemporary Engineering Economics", PrenticeHallofIndia,2011.
2. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg.Press,Texas,2010.
3. Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy", Macmillan, NewYork,2011.
4. ZahidAkhan:"Engineering Economy", DorlingKindersley,2012

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

- Describe the concept of engineering economics. **(K2)**
- Comprehend macroeconomic principles. **(K2)**
- Decision making in diverse business set up. **(K2)**
- Explain the Inflation & Price Change. **(K2)**
- Explain Present Worth Analysis. **(K2)**
- Apply the principles of economics through various case studies. **(K3)**