K.L.N. COLLEGE OF ENGINEERING

Pottapalayam – 630 612, Sivagangai District

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

Estd: 1994

FINAL YEAR
CURRICULUM AND SYLLABUS

REGULATIONS 2020

For Under Graduate Program

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM

(For the students admitted from 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

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

K.L.N. COLLEGE OF ENGINEERING, POTTAPALAYAM

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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 multi disciplinary environments

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PROGRAM OUTCOMES (POs)

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 providevalid 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 engineeringpractice.

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 (HS) Courses** include Technical English, Environmental Science and Engineering, Engineering Ethics and human values, Communication Skills and Management courses.

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 Courses (MC)** include Personality and Character development and the courses recommended by the regulatory bodies such as AICTE, UGC, etc

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B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

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	3	0	0	3
5.		Professional Elective-VI	PE	3	3	0	0	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				**30**	**18**	**0**	**12**	**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				**20**	**0**	**0**	**20**	**10**

K.L.N. COLLEGE OF ENGINEERING, POTTAPALAYAM

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B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

PROFESSIONAL ELECTIVE COURSES: VERTICALS

S. No	Honours					
	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
1.	Power Quality	Modern Power Converters	Power Electronic Converters for Electric Vehicles	Embedded Processors	Modern Control System	Operations Research
2.	Smart Grid	Special Electrical Machines	Electric Vehicles and Power Management	Embedded C-Programming	System Identification and Adaptive Control	Computer Organization and Architecture
3.	Flexible AC Transmission System	Solid State Drives	Electric Vehicle Design, Mechanics and Control	Embedded System Design	Optimal Control	Block Chain Technology
4.	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
5.	High Voltage Engineering	SMPS and UPS	Testing of Electric Vehicles	Smart System Automation	Computer Control of Processes	Soft Computing
6.	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
7.	Under Ground Cable Engineering	Multilevel Power Converters	Intelligent control of Electric Vehicles	VLSI Design	Machine Monitoring System	Energy Storage Systems
8.	Substation Engineering and Automation	Control of Power Electronics Circuits	Design of Electrical Apparatus	MEMS and NEMS	Model Based Control	Probability and Statistics

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V to VII. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals.

Enrolment for B.E. / B. Tech. Minor degree (Optional)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E./B.Tech (Honors) or B.E./B.Tech Minor degree. For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2020 (Amendments), Clause 4 & Clause 16.

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B.E. ELECTRICAL AND ELECTRONICS ENGINEERING
PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL I: MODERN POWER ENGINEERING

S. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
			THEORY					
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
			THEORY					
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
			THEORY					
1.	20EEV13	Power Electronic Convertersfor 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	3	3	0	0	3
4.	20EEV43	Design of Electric Vehicle Charging System	PE	3	3	0	0	3
5.	20 EEV53	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	3	3	0	0	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
THEORY								
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	3	3	0	0	3
6.	20EEV64	Embedded System for Automotive Applications	PE	3	3	0	0	3
7.	20EEV74	VLSI Design	PE	3	3	0	0	3
8.	20EEV84	MEMS and NEMS	PE	3	3	0	0	3

VERTICAL V : ADVANCED CONTROL SYSTEMS ENGINEERING

S. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
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
THEORY								
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 – II (VII SEMESTER)

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

MANAGEMENT ELECTIVE COURSES

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

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:

Course Name :PROTECTION AND SWITCHGEAR											**Course Code : 20EE701**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C401.1	Explain the Over voltage Protection of Power Systems										1	K2	1,2	1,2
C401.2	Explain the characteristics and functions of Electromagnetic type protective relays										2	K2	1,2	1,2
C401.3	Describe the various abnormal conditions in power system apparatusand to select a suitable protection scheme										3	K2	1,2	1,2
C401.4	Develop assembly language programming for numerical over current, directional and distance protection										4	K3	1,2,3,5,8, 12	1,2
C401.5	Analyze the circuit interruption problems										5	K4	1,2,3,4	1,2
C401.6	Explain the operation of Air, Oil, SF6 and Vacuum Circuit Breakers										5	K2	1,2	1,2
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C401.1	2	1	-	-	-	-	-	-	-	-	-	-	2	2
C401.2	2	1	-	-	-	-	-	-	-	-	-	-	2	2
C401.3	2	1	-	-	-	-	-	-	-	-	-	-	2	2
C401.4	3	2	1	-	2	-	-	2	-	-	-	2	3	3
C401.5	3	3	2	1	-	-	-	-	-	-	-	-	3	3
C401.6	2	1	-	-	-	-	-	-	-	-	-	-	2	2

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:

Course Name :RENEWABLE ENERGY SYSTEMS												**Course Code : 20EE702**			
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSOs**
C402.1	Describe about renewable Energy Sources and technologies. Outline the Environmental consequences of fossil fuel use											I	K2	1,2,7,8,12	1,2
C402.2	Discuss the basic principle and types of solar PV system and thermal energy systems											II	K2	1,2,7,8,12	1,2
C402.3	Explain the basic principles, types and Grid integration issues of Wind Energy Conversion Systems											III	K2	1,2,7,8,12	1,2
C402.4	Summarize the electrical power from bio-mass energy and Hydro energy											IV	K2	1,2,7,8,12	1,2
C402.5	Describe the electrical power from geothermal energy, Ocean energy, Hydrogen energy and Fuel cell.											V	K2	1,2,7,8,12	1,2
C402.6	Explain the different types of Hybrid energy systems with their advantages and disadvantages											V	K2	1,2,7,8,12	1,2
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**		**PSO1**	**PSO2**
C402.1	2	1	-	-	-	-	3	3	-	-	-	3		2	2
C402.2	2	1	-	-	-	-	3	3	-	-	-	3		2	2
C402.3	2	1	-	-	-	-	3	3	-	-	-	3		2	2
C402.4	2	1	-	-	-	-	3	3	-	-	-	3		2	2
C402.5	2	1	-	-	-	-	3	3	-	-	-	3		2	2
C402.6	2	1	-	-	-	-	3	3	-	-	-	3		2	2

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.	Compliers: C, C++, VB, VC++	30 Users.

OUTCOMES:

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

COURSE NAME :POWER SYSTEM SIMULATION LABORATORY												Course Code : 20EE7L1		
CO	**Course Outcomes**											**Exp**	**K –CO**	**POs**	**PSOs**
C407.1	Develop coding to determine the various line parameters of a transmission line.											1	K3	1,2,3,4,5,8, 9,10,12	1,2
C407.2	Develop coding to form bus admittance matrix for the given power system network.											2	K3	1,2,3,4,5,8, 9,10,12	1,2
C407.3	Develop program to determine the line losses of the given power system network.											3,4	K3	1,2,3,4,5,8, 9,10,12	1,2
C407.4	Develop simulink model for fault analysis in the transmission line using bus impedance matrix.											5	K4	1,2,3,4,5,8, 9,10,12	1,2
C407.5	Develop the coding to solve the economic dispatch problem in Power system.											7	K3	1,2,3,4,5,8, 9,10,12	1,2
C407.6	Analyze the steady state and Transient stability of the given power system using simulation											6,8,9,10	K4	1,2,3,4,5,8, 9,10,12	1,2
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**		**PSO1**	**PSO2**
C407.1	3	2	1	-	2	-	-	1	1	1	-	1		3	3
C407.2	3	2	1	-	2	-	-	1	1	1	-	1		3	3
C407.3	3	2	1	-	2	-	-	1	1	1	-	1		3	3
C407.4	3	3	2	1	2	-	-	1	1	1	-	1		3	3
C407.5	3	2	1	-	2	-	-	1	1	1	-	1		3	3
C407.6	3	3	2	1	2	-	-	1	1	1	-	1		3	3

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.

PRE-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:

Course Name :RENEWABLE ENERGY SYSTEMS LABORATORY											Course Code : 20EE7L2			
CO	**Course Outcomes**										**Exp**	**K –CO**	**POs**	**PSOs**
C408.1	Analyze VI-Characteristics and Efficiency of 1kWp Solar PV System										2	K4	1,2,3,4 ,5,9,12	1,2
C408.2	Analyze the Shadowing effect & diode based solution in 1kWp Solar PV System										3	K4	1,2,3,4 ,5,9,12	1,2
C408.3	Analyze the Performance of Grid connected and Standalone 1kWp Solar Power System.										4	K4	1,2,3,4 ,5,9,12	1,2
C408.4	Simulate the various Renewable energy sources										1,5,7,9,11	K3	1,2,3,4 ,5,9,12	1,2
C408.5	Analyze the performance characteristics of micro Wind Energy Generator										6	K4	1,2,3,4 ,5,9,12	1,2
C408.6	Analyze the performance characteristics of Hybrid (Solar-Wind) Power System.										8	K4	1,2,3,4 ,5,9,12	1,2
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C408.1	3	3	2	1	1	-	-	-	1	-	-	1	3	3
C408.2	3	3	2	1	1	-	-	-	1	-	-	1	3	3
C408.3	3	3	2	1	1	-	-	-	1	-	-	1	3	3
C408.4	3	2	1	-	1	-	-	-	1	-	-	1	3	3
C408.5	3	3	2	1	1	-	-	-	1	-	-	1	3	3
C408.6	3	3	2	1	1	-	-	-	1	-	-	1	3	3

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 Final year project work and find solution by formulating proper methodology.

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

Course Name : MINI PROJECT-II											Course Code : 20EE7L3			
CO	**Course Outcomes**										**Exp**	**K –CO**	**POs**	**PSOs**
C409.1	Identify and apply the real world and societal importance problems in the Electrical and its allied area.										-	K4	1-12	1,2
C409.2	Identify, analyze, design, implement and handle prototype projects with a complete and organized solution methodologies										-	K4	1-12	1,2
C409.3	Apply modern engineering tools for solution										-	K4	1-12	1,2
C409.4	Contribute as an individual or in a team in development of technical projects										-	K4	1-12	1,2
C409.5	Develop effective communication skills for presentation of project related activities										-	K4	1-12	1,2
C409.6	Prepare reports and examination following professional ethics										-	K4	1-12	1,2
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C409.1	3	3	2	3	1	1	1	1	1	1	1	1	2	2
C409.2	3	3	2	3	1	1	1	1	1	1	1	1	2	2
C409.3	3	3	2	3	3	1	1	1	1	1	1	1	2	2
C409.4	3	3	2	3	1	1	1	1	1	1	1	1	2	2
C409.5	3	3	2	3	1	1	1	1	1	1	1	1	2	2
C409.6	3	3	2	3	1	1	1	1	1	1	1	1	2	2

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:

Course Name : PROJECT WORK / INTERNSHIP											Course Code : 20EE8L1			
CO	**Course Outcomes**										**Exp**	**K –CO**	**POs**	**PSOs**
C410.1	Identify and apply the real world and societal importance problems in the Electrical and its allied area.										-	K4	1-12	1,2
C410.2	Identify, analyze, design, implement and handle prototype projects with a complete and organized solution methodologies										-	K4	1-12	1,2
C410.3	Apply modern engineering tools for solution										-	K4	1-12	1,2
C410.4	Contribute as an individual or in a team in development of technical projects										-	K4	1-12	1,2
C410.5	Develop effective communication skills for presentation of project related activities										-	K4	1-12	1,2
C410.6	Prepare reports and examination following professional ethics										-	K4	1-12	1,2
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C410.1	3	3	2	1	-	3	3	-	-	-	-	3	3	3
C410.2	3	3	2	1	-	-	-	-	-	-	-	-	3	3
C410.3	3	2	1	-	3	-	-	-	-	-	-	-	3	3
C410.4	3	2	1	-	-	-	-	-	3	-	-	-	3	3
C410.5	3	2	1	-	-	-	-	-	-	3	-	-	3	3
C410.6	3	2	1	-	-	-	-	3	-	-	3	-	3	3

PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL I: MODERN POWER ENGINEERING

		L	T	P	C
20EEV51	HIGH VOLTAGE ENGINEERING	3	0	0	3

OBJECTIVES: To impart knowledge on the following Topics

- 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:

Course Name : HIGH VOLTAGE ENGINEERING											**Course Code : 20EEV51**			
CO	**Course Outcomes**										**Exp**	**K –CO**	**POs**	**PSOs**
C4V51.1	Identify the causes of over voltage and its effects in power system.										1	K2	1,2	1
C4V51.2	Explain the breakdown Mechanisms in Solid, Liquid, gases and Composite dielectrics.										2	K2	1,2	1
C4V51.3	Apply different type of Generating circuit for high voltage D.C and high voltage A.C.										3	K2	1,2,3,4,5	1
C4V51.4	Explain t he Measurement of A.C and D.C high voltage and currentusing appropriate method.										4	K2	1,2,5	1
C4V51.5	Analyze the importance of power apparatus testing in Transient studies.										5	K2	1,2,3,4,5	1
C4V51.6	Understand the concept of Insulation coordination.										5	K2	1,2,5	1
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C4V51.1	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C4V51.2	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C4V51.3	2	2	2	-	-	-	-	-	-	-	-	-	1	-
C4V51.4	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C4V51.5	2	2	2	-	-	-	-	-	-	-	-	-	1	-
C4V51.6	2	1	-	-	-	-	-	-	-	-	-	-	1	-

20EEV61	ELECTRIC ENERGY GENERATION, UTILIZATION AND CONSERVATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To discuss the various sources of power generation.
- To understand the principle, design of illumination systems and energy efficiency lamps.
- To explain the various methods of industrial heating and welding.
- To Analyze the behavior & control of electric traction system.
- To understand the principle of Refrigerator and Air Conditioner

PRE-REQUISITE:

Course Code: 20EE201, 20EE304, 20EE401
Course Name: Electric Circuit Analysis, Electrical Machines-I, Electrical Machines-II

UNIT - I POWER GENERATION **9**

Review of conventional methods – thermal, hydro and nuclear based power generation. Non-conventional methods of power generation – fuel cells - tidal waves – wind – geothermal – solar - bio-mass - municipal waste. Cogeneration. Effect of distributed generation on power system operation.

UNIT- II ILLUMINATION ENGINEERING **9**

Nature of radiation – definition – laws of illumination – lighting calculations – design of illumination systems – residential, industrial, commercial, flood lighting and street lighting – types of lamps – energy efficient lamps

UNIT-III HEATING AND WELDING **9**

Role electric heating for industrial applications – Requirement of heating material – Design of heating element – Methods of heating: Resistance heating – Induction heating – Dielectric heating – Methods of welding: Resistance welding – Arc welding – welding generator, welding transformer and the characteristics.

UNIT- IV ELECTRIC DRIVES AND TRACTION **9**

Fundamentals of electric drive - choice of an electric motor - application of motors for particular services - traction motors - characteristic features of traction motor - systems of railway electrification - electric braking - train movement and energy consumption - traction motor control - track equipment and collection gear.

UNIT-V REFRIGERATION AND AIR CONDITIONING **9**

Refrigeration-Domestic refrigerator and water coolers - Air-Conditioning-Various types of air-conditioning system and their applications, smart air conditioning units – Energy Efficient motors: Standard motor efficiency, need for efficient motors

TOTAL: 45 PERIODS

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:

Course Name: Electric Energy Generation, Utilization And Conservation											**Course Code: 20EEV61**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C4V61.1	Describe the basic principles & technologies of various renewable and nonrenewable energy resource-based power generation										I	K2	1,2	1,2
C4V61.2	Categorize different light sources and design various illumination systems for the indoor lighting schemes, factory lighting, halls, outdoor lighting schemes, flood lighting, street lighting										II	K3	1,2,3, 4	1,2
C4V61.3	Classify different methods of electric heating and electric welding in industries.										III	K3	1,2,3	1,2
C4V61.4	Compute the tractive effort for the propulsion of train, name the traction motors, list the traction motor control, track equipment and collection gear.										IV	K3	1,2,3	1,2
C4V61.5	Describe the selection of electrical drives based on the industrial applications.										IV	K2	1,2	1,2
C4V61.6	Explain the concept of Air conditioner and refrigerator.										V	K2	1,2	1,2
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C4V61.1	2	1	-	-	-	-	-	-	-	-	-	-	1	1
C4V61.2	3	3	2	-	-	-	-	-	-	-	-	-	3	1
C4V61.3	3	2	1	-	-	-	-	-	-	-	-	-	2	1
C4V61.4	3	2	1	-	-	-	-	-	-	-	-	-	2	1
C4V61.5	2	1	-	-	-	-	-	-	-	-	-	-	1	1
C4V61.6	2	1	-	-	-	-	-	-	-	-	-	-	1	1

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:

Course Code: 20EE402

Course Name: Transmission and Distribution

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 Edition2012.
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 LVDN:https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9807279, June 2022.

OUTCOMES:

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

Course Name: UNDER GROUND CABLE ENGINEERING												**Course Code: 20EEV71**			
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSOs**
C4V71.1	Describe the development of underground cable system.											1	K2	1,2	1,2
C4V71.2	Summarize the architecture of UG cable, physical and electrical characteristics of the UG cable.											2	K2	1,2	1,2
C4V71.3	Discuss the different types of cable used in distribution system.											3	K2	1,2	1,2
C4V71.4	Explain about the underground cables used in transmission system											4	K2	1,2	1,2
C4V71.5	Summarize the cable installations procedures and practices.											5	K2	1,2	1,2
C4V71.6	Discuss the theory /methodology of cable fault detection and rectification, testing and maintenance											5	K2	1,2	1,2
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	
C4V71.1	2	1	-	-	-	-	-	-	-	-	-	-	1	1	
C4V71.2	2	1	-	-	-	-	-	-	-	-	-	-	1	1	
C4V71.3	2	1	-	-	-	-	-	-	-	-	-	-	1	1	
C4V71.4	2	1	-	-	-	-	-	-	-	-	-	-	1	1	
C4V71.5	2	1	-	-	-	-	-	-	-	-	-	-	1	1	
C4V71.6	2	1	-	-	-	-	-	-	-	-	-	-	1	1	

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:

Course Code: 20EE701
Course Name: Protection and Switchgear

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, Over current 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. McDonald John D, “Electric Power Substations Engineering”, CRC Press, 3rd Edition, 2012.

2. Partap Singh Satnam, P.V. Gupta, “Sub-station Design and Equipment”, Dhanpat Rai Publications, 1st Edition, 2013.

3. Sunil S. Rao, “Switchgear Protection and Power Systems (Theory, Practice & Solved Problems)”, Khanna Publications, 14th Edition, 2019 .

REFERENCES:

1. Electrical substation and engineering & practice by S.Rao, 3rd Edition, Khanna Publishers 2015.

2. Manual on Substation by Central Board of irrigation and Power (CBIP) Publication No 342., 2006.

OUTCOMES:

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

Course Name: SUBSTATION ENGINEERING AND AUTOMATION												Course Code: 20EEV81		
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSOs**
C4V81.1	Explain the key deciding factors involved in substation design and operation.											1	K2	1,2,3,5,6,7,8,12	1
C4V81.2	Describe the sizing and selection of equipment which forms part of substation											2	K2	1,2,3,4,5,6,8,9,12	1
C4V81.3	Explain about composite layout design aspects of the substation with different services and the challenges including statutory clearances.											3	K2	1,2,3,4,5,6,8,9,12	1
C4V81.4	Describe about Interdisciplinary aspects involved in substation design											4	K2	1,2,3,6,7,8,9,12	1
C4V81.5	Describe different protection and control scheme involved in substation design											4	K2	1,2,3,4,6,7,8,9,12	1
C4V81.6	Explain about substation automation system and different communication protocol involved for efficient operation of a substation											5	K2	2,3,4,6,8,12	1
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	
C4V81.1	1	3	2	-	2	1	3	2	-	-	-	3	3	-	
C4V81.2	3	3	3	3	2	3	-	1	2	-	-	2	3	-	
C4V81.3	3	2	3	3	1	3	-	2	2	-	-	3	3	-	
C4V81.4	3	1	2	-	-	3	2	1	2	-	-	2	3	-	
C4V81.5	3	3	3	3	-	3	2	1	1	-	-	3	3	-	
C4V81.6	-	2	3	3	-	3	-	1	-	-	-	3	3	-	

VERTICAL II: POWER ELECTRONICS CONVERTERS AND DRIVES

20EEV52	SMPS AND UPS	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:
Course Code: 20EE502
Course Name: Power Electronics

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 MODE POWER 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 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 Edition2005.
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:

Course Name :SMPS AND UPS											**Course Code :20EEV52**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C4V52.1	Explain the operation and state space modeling of DC-DC converters										1	K2	1,2	1
C4V52.2	Describe the operation and state space modeling of switched mode power converters										2	K2	1,2	1
C4V52.3	Discuss the basic concept and operation of resonant converters										3	K2	1,2	1
C4V52.4	Summarize the PWM techniques for DC-AC converters										4	K2	1,2	1
C4V52.5	Explain the operation of Power conditioners, UPS and its applications in electric power utility.										5	K2	1,2	1
C4V52.6	Describe the operation of various types of filters										5	K2	1,2	1
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C4V52.1	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C4V52.2	2	1	-	**-**	-	-	**-**	-	-	**-**	-	-	1	-
C4V52.3	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C4V52.4	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C4V52.5	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C4V52.6	2	1	-	-	-	-	-	-	-	-	-	-	1	-

20EEV62	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- 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
Course Name: Power Electronics

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, 2nd Edition, 4th Edition ,

2017
3. D.P.Kothari, K.C Singal, Rakesh Ranjan “Renewable Energy Sources and Emerging Technologies”, PHI Learning Pvt. Ltd, New Delhi, 2013
4. Rai.G.D, ”Solar energy utilization”, Khanna publishers, 5th Edition, 2008
5. Rai G.D., Non-Conventional Energy Sources, Khanna Publishers, 2011
6. H.Khan, "Non-conventional Energy sources", Tata McGraw-hill Publishing Company, New Delhi, 2017, 3rd Edition.

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:

Course Name : Power Electronics for Renewable Energy Systems											**Course Code :20EEV62**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C4V62.1	Discuss the various types of renewable energy sources										1	K2	1,2	1
C4V62.2	Describe the performance of IG,PMSG,SCIG AND DFIG										2	K2	1,2	1
C4V62.3	Describe different power converters namely AC to DC,DC to DC and Ac to AC converters for renewable energy sources										3	K2	1,2	1
C4V62.4	Explain the various operating modes of wind electrical generators and solar energy systems										4	K2	1,2	1
C4V62.5	Describe the various operating modes of solar energy systems										4	K2	1,2	1
C4V62.6	Explain the maximum power point tracking algorithms										5	K2	1,2	1
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C4V62.1	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C4V62.2	2	1	**-**	**-**	-	-	**-**	-	-	**-**	-	-	1	-
C4V62.3	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C4V62.4	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C4V62.5	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C4V62.6	2	1	-	-	-	-	-	-	-	-	-	-	1	-

20EEV72	MULTILEVEL POWER CONVERTERS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn multilevel topology (Symmetry & Asymmetry) with common DC bus link.
- To study the working of cascaded H-Bridge, Diode Clamped and Flying Capacitor MLI.
- To study the working of MLI with reduced switch count.
- To simulate three level diode clamped MLI and three level flying capacitor based MLI with resistive and reactive load
- To simulate the MLI with reduced switch count

PRE-REQUISITE:

Course Code: 20EE502
Course Name: Power Electronics

UNIT - I MULTILEVEL TOPOLOGIES 9

Introduction – Generalized Topology with a Common DC bus – Converters derived from the generalized topology – symmetric topology without a common DC link – Asymmetric topology.

UNIT - II CASCADED H-BRIDGE MULTILEVEL INVERTERS 9

Introduction - H-Bridge Inverter, Bipolar Pulse Width Modulation, Unipolar Pulse Width Modulation. Multilevel Inverter Topologies, CHB Inverter with Equal DC Voltage, H-Bridges with Unequal DC Voltages — PWM, Carrier-Based PWM Schemes, Phase-Shifted Multicarrier Modulation, Level-Shifted Multicarrier Modulation, Comparison Between Phase- and Level-Shifted PWM Schemes-Staircase Modulation

UNIT - III DIODE CLAMPED MULTILEVEL CONVERTER 9

Introduction – Converter structure and Functional Description – Modulation of Multi level converters – Voltage balance Control – Effectiveness Boundary of voltage balancing in DCMC converters – Performance results

UNIT - IV FLYING CAPACITOR MULTILEVEL CONVERTER 9

Introduction – Flying Capacitor topology – Modulation scheme for the FCMC – Dynamic voltage balance of FCMC.

UNIT - V MULTILEVEL CONVERTER WITH REDUCED SWITCH COUNT 9

Multi level inverter with reduced switch count - structures, working principles and pulse generation methods.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Rashid M.H, ”Power Electronics Circuits, Devices and Applications”, Prentice Hall India, Third Edition, New Delhi, 2014 Pearson 4th edition.
2. Rashid.M.H, “Power electronics Handbook” ,Academic press, 2nd Edition, 4th Edition , 2017
3. Sergio Alberto Gonzalez, Santiago Andres Verne, MariaInes Valla, ”Multi level Converters for Industrial Applications”, CRC Press, 22-Jul-2013, 2017 ,1st Edition.

4. BinWu, Meh di Narimani, High Power Converters and AC drives by IEEE press 2017, 2nd Edition.

REFERENCES:

1. Thomas A. Lipo, Pulse Width Modulation for Power Converters: Principles and Practice, D.Grahame Holmes, John Wiley & Sons, Oct-2003, 1st Edition.
2. Fang Lin Luo, Hong Ye, Advanced DC/AC Inverters: Applications in Renewable Energy, CRC Press, 22-Jan-2013, 2017, 1st Edition.
3. Hani Vahedi, Mohamed Trabelsi, Single-DC-Source 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:

Course Name : MULTILEVEL POWER CONVERTERS												**Course Code :20EEV72**			
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSOs**
C4V72.1	Classify the different topologies of multi level inverters (MLIs) with and without DC link capacitor											1	K3	1,2,3	1
C4V72.2	Derive the performance of MLI switch Bipolar Pulse Width Modulation (PWM) Unipolar PWM Carrier-Based PWM Schemes Phase Level Shifted Multi carrier Modulation											2	K3	1,2,3	1
C4V72.3	Explain the working principles of Cascaded H-Bridge MLI, diode clamped MLI, flying capacitor MLI and MLI with reduced switch count											3	K2	1,2	1
C4V72.4	Describe the voltage balancing performance in Diode clamped MLI.											4	K2	1,2	1
C4V72.5	Explain the three level, capacitor clamed and diode clamped MLI with R and RL load											4	K2	1,2	1
C4V72.6	Explain MLI with reduced switch configuration using fundamental switching scheme											5	K2	1,2	1
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	
C4V72.1	3	2	1	-	-	-	-	-	-	-	-	-	1	-	
C4V72.2	3	2	1	-	-	-	-	-	-	-	-	-	1	-	
C4V72.3	2	1	-	-	-	-	-	-	-	-	-	-	1	-	
C4V72.4	2	1	-	-	-	-	-	-	-	-	-	-	1	-	
C4V72.5	2	1	-	-	-	-	-	-	-	-	-	-	1	-	
C4V72.6	2	1	-	-	-	-	-	-	-	-	-	-	1	-	

20EEV82	CONTROL OF POWER ELECTRONICS CIRCUITS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the basics of control system simulation.
- To do symbolic calculation.
- To study the principles of sliding mode control and the way of apply smc for buck converter.
- To learn the concept of power factor correction.
- To design simulate smc for buck converter and power factor correction circuit with controller

PRE-REQUISITE:

Course Code: 20EE502, 20EE504
Course Name: Power Electronics, Control Systems

UNIT - I SIMULATION BASICS IN CONTROL SYSTEMS 9

Transfer Function - How to build transfer function, identify Poles, zeros, draw time response plots, bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state space modeling - transfer function from state space Model

UNIT - II SYMBOLIC CALCULATIONS 9

Symbolic Variables - Symbolic Vector Variables, Commands for Handling Polynomial Expressions - Extracting Parts of a Polynomial -. Factorization and Roots of Polynomials, Symbolic Matrix Algebra - Operations with Symbolic Matrices – Other Symbolic Matrix Operations.

UNIT - III SLIDING MODE CONTROL BASICS 9

Introduction - Introduction to Sliding - Mode Control - Basics of Sliding - Mode Theory- Application of Sliding - Mode Control to DC-DC Converters – Principle - Sliding mode control of buck converter.

UNIT - IV POWER FACTOR CORRECTION CIRCUITS 9

Introduction, Operating Principle of Single-Phase PFCs, Control of boost converter based PFCs, Designing the Inner Average-Current-Control Loop, Designing the Outer Voltage-Control Loop, Example of Single-Phase PFC Systems.

UNIT - V CONTROLLER DESIGN FOR PFC CIRCUITS 9

Power factor correction circuit using other SMPS topologies: Cuk and SEPIC converter - PFC circuits employing bridgeless topologies.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Marian K.Kazimierczuk and Agasthya Ayachit, ”Laboratory Manual for Pulse-Width Modulated DC-DC Power Converters”, Wiley2016, 1st Edition.
2. Rashid M.H, ”Power Electronics Circuits, Devices and Applications”, Prentice Hall India, Third Edition, New Delhi, 2014 Pearson 4th edition.
3. Rashid.M.H “Power electronics Handbook”, Academic press, 2nd Edition, 4th Edition,

2017
4. Feedback Control problems using MATLAB and the Control system toolbox By Dean Frederick and Joe Chow, 2000, 1st Edition, Cengage Learning.
5. Ned Mohan," Power Electronics: A First Course", Johnwiley, 2013, 1st Edition.

REFERENCES:

1. Sliding mode control for Switching Power Converters:, Techniques and Implementation, Slew-Chong Tan, Yuk Ming Lai Chi-Kong Tse, 1st Edition, CRC Press.
2. Andre Kislovski, "Dynamic Analysis of Switching-Mode DC/DC Converters", Springer 1991.
3. MATLAB Symbolic Algebra and Calculus Tools, Lopez Cesar, Apress, 2014.

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

Course Name : CONTROL OF POWER ELECTRONICS CIRCUITS												**Course Code :20EEV82**			
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSOs**
C4V82.1	Calculate transfer function for constant, differential, integral, First order and Second order factors.											1	K3	1,2,3	1
C4V82.2	Illustrate the effect of poles and zero's in the 's' plane.											2	K3	1,2,3	1
C4V82.3	Select Symbolic equations for solving problems related with Matrices, Polynomial and vectors.											3	K3	1,2,3	1
C4V82.4	Compute the control expression for DC–DC buck converter using sliding mode control theory											4	K3	1,2,3	1
C4V82.5	Determine the controller expression for power factor correction circuits.											4	K3	1,2,3	1
C4V82.6	Compute sliding mode control of buck converter and power factor correction circuit.											5	K3	1,2,3	1
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	
C4V82.1	3	2	1	-	-	-	-	-	-	-	-	-	1	-	
C4V82.2	3	2	1	-	-	-	-	-	-	-	-	-	1	-	
C4V82.3	3	2	1	-	-	-	-	-	-	-	-	-	1	-	
C4V82.4	3	2	1	-	-	-	-	-	-	-	-	-	1	-	
C4V82.5	3	2	1	-	-	-	-	-	-	-	-	-	1	-	
C4V82.6	3	2	1	-	-	-	-	-	-	-	-	-	1	-	

VERTICAL III: ELECTRIC VEHICLE TECHNOLOGY

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: 20EE304, 20EE502
Course Name: Electrical Machines-I, Power Electronics

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, 1st Edition.
2. Electromagnetic Compatibility of Electric Vehicle, Li Zhai, Springer 2021, 1st Edition.

REFERENCES:

1. EMC and Functional Safety of Automotive Electronics, Kai Borgeest, IET2018, 1st Edition.
2. EMI/EMC Computational Modeling Handbook, Druce Archambeault, colinbranch, Omar M.Ramachi Springer 2012, 2nd Edition.
3. Automotive EMC, Mark Steffika, Springer 2013,1st Edition.
4. Electric Vehicle Systems Architecture and Standardization Needs, Reports of the PPP European Green Vehicles Initiative, Beate Müller, Gereon Meyer, Springer 2015, 1st Edition.

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

Course Name : TESTING OF ELECTRIC VEHICLES											**Course Code :20EEV53**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C4V53.1	Describe the status and other details of standardization of EVs										1	K2	1,2	1
C4V53.2	Discuss the testing protocols for EVs and HEV components										2	K2	1,2	1
C4V53.3	Explain the safety cycle and need for functions safety for EVs										3	K2	1,2	1
C4V53.4	Discuss the problems related with EMC for EV components.										4	K2	1,2	1
C4V53.5	Explain the EMI in motor drive										5	K2	1,2	1
C4V53.6	Describe the EMI in DC-DC converter system.										5	K2	1,2	1
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C4V53.1	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C4V53.2	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C4V53.3	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C4V53.4	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C4V53.5	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C4V53.6	2	1	-	-	-	-	-	-	-	-	-	-	1	-

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

Course Code: 20EE402, 20EE501

Course Name: Transmission and Distribution, Power System Analysis

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 Shahnia 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:

Course Name : GRID INTEGRATION OF ELECTRIC VEHICLES												**Course Code :20EEV63**			
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSOs**
C4V63.1	Explain the concepts related with V2G											I	K2	1,2	-
C4V63.2	Discuss the grid connection of 3 phase Q inverter											II	K2	1,2	-
C4V63.3	Explain the technical, economics. business, regulatory & political challenges related with V2G											III	K2	1,2	-
C4V63.4	Describe the impact of EV and V2G on smart grid system											IV	K2	1,2	-
C4V63.5	Explain the impact of EV and V2G on renewable energy system											IV	K2	1,2	-
C4V63.6	Explain the concept of grid integration and management of EVs											V	K2	1,2	-
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	
C4V63.1	2	1	-	-	-	-	-	-	-	-	-	-	1	-	
C4V63.2	2	1	-	-	-	-	-	-	-	-	-	-	1	-	
C4V63.3	2	1	-	-	-	-	-	-	-	-	-	-	1	-	
C4V63.4	2	1	-	-	-	-	-	-	-	-	-	-	1	-	
C4V63.5	2	1	-	-	-	-	-	-	-	-	-	-	1	-	
C4V63.6	2	1	-	-	-	-	-	-	-	-	-	-	1	-	

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 ANALYSIS OF THE BLDC MOTOR **6**

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:

Course Name : INTELLIGENT CONTROL OF ELECTRIC VEHICLES												**Course Code :20EEV73**			
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSOs**
C4V73.1	Derive the mathematical model of a BLDC motor and to discuss about its characteristics											1	K3	1,2,3	-
C4V73.2	Demonstrate the PID control, and windup controller, Intelligent Controller and Vector Control, Control applied to BLDC motor.											2	K3	1,2,3	-
C4V73.3	Illustrate the basics of fuzzy logic system											3	K2	1,2	-
C4V73.4	Describe the basics of VHDL applied to control of EVs.											4	K2	1,2	-
C4V73.5	Describe the basics of FPGA applied to control of EVs.											4	K2	1,2	-
C4V73.6	Demonstrate Fuzzy logic controller for BLDC motor using simulation											5	K3	1,2,3	-
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	
C4V73.1	3	2	1	-	-	-	-	-	-	-	-	-	1	-	
C4V73.2	3	2	1	-	-	-	-	-	-	-	-	-	1	-	
C4V73.3	2	1	-	-	-	-	-	-	-	-	-	-	1	-	
C4V73.4	2	1	-	-	-	-	-	-	-	-	-	-	1	-	
C4V73.5	2	1	-	-	-	-	-	-	-	-	-	-	1	-	
C4V73.6	3	2	1	-	-	-	-	-	-	-	-	-	1	-	

20EEV83	DESIGN OF ELECTRICAL APPARATUS	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart knowledge on the following Topics

- 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 SPublications, 2008.

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

Course Name : DESIGN OF ELECTRICAL APPARATUS											**Course Code :20EEV83**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C4V83.1	Derive the design considerations for rotating and static electrical machines.										I	K3	1,2,3	2
C4V83.2	Develop the design parameters for lap and wave winding for DC machines.										I	K3	1,2,3	2
C4V83.3	Analyze the design parameters of single and three phase transformer.										II	K4	1,2,3,4	2
C4V83.4	Apply the mathematical knowledge to design armature and field of DC machines.										III	K3	1,2,3	2
C4V83.5	Apply the mathematical knowledge to design stator and rotor of induction motor.										IV	K3	1,2,3	2
C4V83.6	Develop the design parameters for stator and rotor of synchronous machines.										V	K3	1,2,3	2
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C4V83.1	3	2	1	-	-	-	-	-	-	-	-	-	-	2
C4V83.2	3	2	1	-	-	-	-	-	-	-	-	-	-	2
C4V83.3	3	3	2	1	-	-	-	-	-	-	-	-	-	2
C4V83.4	3	2	1	-	-	-	-	-	-	-	-	-	-	2
C4V83.5	3	2	1	-	-	-	-	-	-	-	-	-	-	2
C4V83.6	3	2	1	-	-	-	-	-	-	-	-	-	-	2

VERTICAL IV: EMBEDDED SYSTEMS AND CONTROLLERS

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: **30 PERIODS**

1. Laboratory exercise: Use Arduino / Rpi / any other Embedded processors to give training to understand concepts related to smart automation.
   a) 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: 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, 1stEdition
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://robolabor.ee/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

OUTCOMES:

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

Course Name : SMART SYSTEM AUTOMATION													Course Code : 20EEV54	
CO	**Course Outcomes**												**Unit**	**K –CO**	**POs**	**PSOs**
C4V54.1	Discuss the overview and communication protocols used for smart systems.												1	K2	1,2	1,2
C4V54.2	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												2	K2	1,2,6,8,9, 10	1,2
C4V54.3	Describe the Architecture, Energy Measurement Technique, Security Considerations of Smart Meters. Design and implementation of a smart home system.												3	K2	1,2,6,8,9, 10	1,2
C4V54.4	Summarize the function of Body Area Networks, Sensors, communication protocol and Applications of smart Wearable devices. Conduct the GSM Based Home Devices Control.												4	K3	1,2,3,6,8, 9,10	1,2
C4V54.5	Outline the Fundamental concepts and Controllers components of Robotics												5	K2	1,2	1,2
C4V54.6	Demonstrate the Pick and place robots using Arduino / any suitable Embedded processor.												5	K3	1,2,3,6,8, 9,10	1,2
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**		
C4V54.1	2	1	-	-	-	-	-	-	-	-	-	-	2	2		
C4V54.2	2	1	-	-	-	2	-	2	2	1	-	-	2	2		
C4V54.3	2	1	-	-	-	2	-	2	2	1	-	-	2	2		
C4V54.4	3	2	1	-	-	2	-	2	2	1	-	-	3	3		
C4V54.5	2	1	-	-	-	-	-	-	-	-	-	-	3	3		
C4V54.6	3	2	1	-	-	2	-	2	2	1	-	-	2	2		

20EEV64	EMBEDDED SYSTEM FOR AUTOMOTIVE APPLICATIONS	L	T	P	C
		2	0	2	3

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: 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, Mehrdedehsani, 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:

Course Name : EMBEDDED SYSTEM FOR AUTOMOTIVE APPLICATIONS													Course Code : 20EEV64	
CO	**Course Outcomes**												**Unit**	**K –CO**	**POs**	**PSOs**
C4V64.1	Outline the overview of Automotive systems												1	K2	1,2	1,2
C4V64.2	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												2	K3	1,2,3,5,6, 8,9,10	1,2
C4V64.3	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												3	K3	1,2,3,5,6, 8,9,10	1,2
C4V64.4	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												4	K3	1,2,3,5,6, 8,9,10	1,2
C4V64.5	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												5	K3	1,2,3,5,6, 8,9,10	1,2
C4V64.6	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												5	K3	1,2,3,5,6, 8,9,10	1,2
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**		
C4V64.1	2	1	-	-	-	-	-	-	-	-	-	-	2	2		
C4V64.2	3	2	1	-	2	2	-	2	2	1	-	-	2	2		
C4V64.3	3	2	1	-	2	2	-	2	2	1	-	-	2	2		
C4V64.4	3	2	1	-	2	2	-	2	2	1	-	-	3	3		
C4V64.5	3	2	1	-	2	2	-	2	2	1	-	-	3	3		
C4V64.6	3	2	1	-	2	2	-	2	2	1	-	-	2	2		

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, Addision 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:

Course Name :VLSI DESIGN											**Course Code :20EEV74**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C4V74.1	Explain the concepts of digital building blocks using MOS transistor.										I	K2	1,2	-
C4V74.2	Describe combinational MOS circuits and power strategies										II	K2	1,2	-
C4V74.3	Illustrate the concept of Sequential Circuits and low power memory circuits.										III	K2	1,2	-
C4V74.4	Explain the arithmetic building blocks and memory subsystems										IV	K2	1,2	-
C4V74.5	Discuss the concept of full custom and semi custom design										V	K2	1,2	-
C4V74.6	Explain the FPGA interconnect routing procedures										V	K2	1,2	-
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C4V74.1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C4V74.2	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C4V74.3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C4V74.4	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C4V74.5	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C4V74.6	2	1	-	-	-	-	-	-	-	-	-	-	-	-

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 – Piezo-resistive Sensors – Piezo-electric 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: 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:

Course Name : MEMS AND NEMS													Course Code : 20EEV84	
CO	**Course Outcomes**												**Unit**	**K –CO**	**POs**	**PSOs**
C4V84.1	Explain the material properties and the significance of MEMS and NEMS for industrial automation.												1	K2	1,2	1,2
C4V84.2	Discuss the process of micromachining and micro fabrication techniques												2	K2	1,2	1,2
C4V84.3	Summarize the fabrication mechanism for MEMS sensor and actuators. Conduct an experiment to Simulate the piezoresistive sensor and Piezoelectric actuator using Multi physics tool												3	K3	1,2,3,5,6, 8,9,10	1,2
C4V84.4	Explain the fabrication techniques of NEMS to models, simulate and process the sensors and actuators												4	K2	1,2	1,2
C4V84.5	Infer the improved Employability and entrepreneurship capacity due to knowledge upgradation on MEMS and NEMS technology.												5	K2	1,2	1,2
C4V84.6	Describe the operation of biosensor, micro motor and smart sensor. Conduct an experiment to Simulate the performance of a biosensor and micro motor												5	K3	1,2,3,5,6, 8,9,10	1,2
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**		
C4V84.1	2	1	-	-	-	-	-	-	-	-	-	-	2	2		
C4V84.2	3	2	1	-	2	2	-	2	2	1	-	-	2	2		
C4V84.3	2	1	-	-	-	-	-	-	-	-	-	-	2	2		
C4V84.4	2	1	-	-	-	-	-	-	-	-	-	-	3	3		
C4V84.5	2	1	-	-	-	-	-	-	-	-	-	-	3	3		
C4V84.6	3	2	1	-	2	2	-	2	2	1	-	-	2	2		

VERTICAL V: ADVANCED CONTROL SYSTEMS ENGINEERING

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:

Course Code: 20EE504
Course Name: Control Systems

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, 1st Edition, 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:

Course Name : COMPUTER CONTROL OF PROCESSES											**Course Code : 20EEV55**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C4V55.1	Develop mathematical models for discrete time systems using state variable techniques and analyze the stability of the systems.										1	K3	1,2,3	1,2
C4V55.2	Develop models from input-output data by least square and recursive least square method.										2	K3	1,2,3	1,2
C4V55.3	Develop different digital controllers to satisfy the required criterion.										3	K3	1,2,3	1,2
C4V55.4	Derive a multi-loop controller and multivariable controller for multi-variable systems.										4	K3	1,2,3	1,2
C4V55.5	Derive multivariable dynamic matrix controller for industrial processes.										5	K3	1,2,3	1,2
C4V55.6	Explain various case studies on future implementation on controller design.										5	K2	1,2	1,2
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C4V55.1	3	2	1	-	-	-	-	-	-	-	1	-	2	1
C4V55.2	3	2	1	-	-	-	-	-	-	-	1	-	2	1
C4V55.3	3	2	1	-	-	-	-	-	-	-	1	-	2	1
C4V55.4	3	2	1	-	-	-	-	-	-	-	1	-	2	1
C4V55.5	3	2	1	-	-	-	-	-	-	-	1	-	2	1
C4V55.6	2	1	-	-	-	-	-	-	-	-	1	-	2	1

20EEV65	PRINCIPLES OF ROBOTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the functional elements of Robotics.
- To impart knowledge on the direct and inverse kinematics.
- To introduce the manipulator differential motion and control.
- To educate on various path planning techniques.
- To introduce the dynamics and control of manipulators.

PRE-REQUISITE:

Course Code: 20EE504
Course Name: Control systems

UNIT I BASIC CONCEPTS 9

Brief history-Types of Robot technology-Robot classifications and specifications-Design and control issues- Various manipulators – Sensors - work cell - Programming languages.

UNIT II DIRECT AND INVERSE KINEMATICS 9

Mathematical representation of Robots - Position and orientation – Homogeneous transformation-Various joints- Representation using the Denavit Hattenberg parameters -Degrees of freedom-Direct kinematics-Inverse kinematics- SCARA robots- Solvability – Solution methods-Closed form solution.

UNIT III MANIPULATOR DIFFERENTIAL MOTION AND STATICS 9

Linear and angular velocities-Manipulator Jacobian - Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance.

UNIT IV PATH PLANNING 9

Definition-Joint space technique-Use of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation Planning.

UNIT V DYNAMICS AND CONTROL 9

Lagrangian mechanics-2DOF Manipulator-Lagrange Euler formulation-Dynamic model – Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. R.K.Mittal and I.J.Nagrath, ‘Robotics and Control’, Tata McGraw Hill, New Delhi, 4th Reprint, 2005.
2. JohnJ.Craig ,’Introduction to Robotics Mechanics and Control’, Third edition, Pearson Education,2009.
3. M.P.Groover, M.Weiss, R.N. Nageland N. Godrej, ‘Industrial Robotics’, McGraw-HillSingapore, 1996.

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:

Course Name : PRINCIPLES OF ROBOTICS											**Course Code : 20EEV65**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C4V65.1	Explain basic concept of robotics.										1	K2	1,2	1,2
C4V65.2	Explain the kinematics of robotic system.										2	K2	1,2	1,2
C4V65.3	Describe Instrumentation systems and their applications.										3	K2	1,2	1,2
C4V65.4	Explain the differential motion and statics in robotics.										4	K2	1,2	1,2
C4V65.5	Explain the various path planning techniques.										5	K2	1,2	1,2
C4V65.6	Explain the dynamics and control in robotics industries.										5	K2	1,2	1,2
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C4V65.1	2	1	-	-	-	-	-	-	-	-	-	-	1	1
C4V65.2	2	1	-	-	-	-	-	-	-	-	-	-	1	1
C4V65.3	2	1	-	-	-	-	-	-	-	-	-	-	1	1
C4V65.4	2	1	-	-	-	-	-	-	-	-	-	-	1	1
C4V65.5	2	1	-	-	-	-	-	-	-	-	-	-	1	1
C4V65.6	2	1	-	-	-	-	-	-	-	-	-	-	1	1

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:

Course Code: 20EE503
Course Name: Digital Signal Processing

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:

Course Name : MACHINE MONITORING SYSTEM											**Course Code : 20EEV75**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C4V75.1	Identify the faults in machinery L1.										1	K3	1,2,3	1,2
C4V75.2	Choose the proper maintenance strategies and condition monitoring techniques for identification of failure in a machine L3.										2	K3	1,2,3	1,2
C4V75.3	Construct a classifier model for machine learning based fault diagnosis L5.										3	K3	1,2,3	1,2
C4V75.4	Predict the faulty component in a machine by analyzing the acquired vibration signals L2.										4	K3	1,2,3	1,2
C4V75.5	Build a model using modern tools L4.										5	K3	1,2,3	1,2
C4V75.6	Apply the concept of Machine learning for condition monitoring										5	K3	1,2,3	1,2
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C4V75.1	3	2	1	-	-	-	-	-	-	-	-	-	1	2
C4V75.2	3	2	1	-	-	-	-	-	-	-	-	-	1	2
C4V75.3	3	2	1	-	-	-	-	-	-	-	-	-	1	2
C4V75.4	3	2	1	-	-	-	-	-	-	-	-	-	1	2
C4V75.5	3	2	1	-	-	-	-	-	-	-	-	-	1	2
C4V75.6	3	2	1	-	-	-	-	-	-	-	-	-	1	2

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:

Course Code: 20EE504
Course Name: Control systems

UNIT - I INTRODUCTION TO MIMO CONTROL 9

Introduction to MIMO Systems – Multivariable control – Multi loop 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 ADAPTIVECONTROLSCHEME 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. 1st Edition.
2. Ridong Zhang, Anke Xue Furong Gao, "Model Predictive Control Approaches Based on the Extended State Space Model and Extended Non-minimal State Space Model", Springer Nature Singapore Pte Ltd. 2019, 1st Edition.
3. J.A. ROSSITER "Model-Based Predictive Control A Practical Approach" Taylor & Francis e-Library, 2005, 1st edition.

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

Course Name : MODEL BASED CONTROL												**Course Code : 20EEV85**		
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSOs**
C4V85.1	Apply engineering knowledge to design the control schemes on MIMO systems											1	K3	1,2,3	1,2
C4V85.2	Develop controller for MIMO system											2	K3	1,2,3	1,2
C4V85.3	Build the control schemes available in industries											3	K3	1,2,3	1,2
C4V85.4	Predict MPC and Adaptive controllers for practical engineering problems											4	K3	1,2,3	1,2
C4V85.5	Apply suitable controllers for the given problems											5	K3	1,2,3	1,2
C4V85.6	Explain the various case studies on advanced controller for future implementation.											5	K2	1,2	1,2
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**		**PSO1**	**PSO2**
C4V85.1	3	2	1	-	-	-	-	-	-	-	-	-		1	2
C4V85.2	3	2	1	-	-	-	-	-	-	-	-	-		1	2
C4V85.3	3	2	1	-	-	-	-	-	-	-	-	-		1	2
C4V85.4	3	2	1	-	-	-	-	-	-	-	-	-		1	2
C4V85.5	3	2	1	-	-	-	-	-	-	-	-	-		1	2
C4V85.6	2	1	-	-	-	-	-	-	-	-	-	-		1	2

VERTICAL VI: DIVERSIFIED COURSES

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, EijiMizutani, “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:

Course Name : SOFT COMPUTING													**Course Code :20EEV56**	
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSOs**
C4V56.1	Explain the different categories of soft computing techniques											1	K2	1,2,8, 9	-
C4V56.2	Illustrate neural networks modeling for different applications											2	K3	1,2,3, 8,9,12	-
C4V56.3	Apply fuzzy design principles for solving various fuzzy problems											3	K3	1,2,3, 8,9,12	-
C4V56.4	Explain the different operators and phases of genetic algorithm											4	K2	1,2, 8,9,10	-
C4V56.5	Illustrate the techniques for developing hybrid fuzzy based systems											5	K3	1,2,3,5,6 8,9,12	-
C4V56.6	Apply different soft computing tools to solve engineering problems											5	K3	1,2,3,5,6 8,9,12	-
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	
C4V56.1	2	1	-	-	-	-	-	2	2	-	-	-	-	-	
C4V56.2	3	2	1	-	-	-	-	2	2	-	-	1	-	-	
C4V56.3	3	2	1	-	-	-	-	2	2	-	-	1	-	-	
C4V56.4	2	1	-	-	-	-	-	2	2	1	-		-	-	
C4V56.5	3	2	1	-	1	1	-	2	2	-	-	1	-	-	
C4V56.6	3	2	1	-	1	1	-	2	2	-	-	1	-	-	

20EEV66	BIOMEDICAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To Introduce Fundamentals of Biomedical Engineering
- To understand the measurement of non-electrical parameters and diagnostic procedure.
- To study measurement of certain important electrical parameters and analysis.
- To understand the basic principles in imaging techniques.
- To understand the basic knowledge in life assisting and therapeutic devices.

PRE-REQUISITE:

Course Code: 20EE403, 20EE404

Course Name: Linear Integrated Circuits and Applications, Measurements and Instrumentation

UNIT-I FUNDAMENTALS OF BIOMEDICAL ENGINEERING 9

Cell and its structure – Resting and Action Potential – Propagation of potential -Nervous system and its fundamentals - Cardiovascular systems- Respiratory systems –Kidney and blood flow - Basic components of a biomedical system- Physiological signals and transducers – selection criteria – Piezoelectric, ultrasonic transducers -Temperature measurements -Fibre optic temperature sensors.

UNIT-II NON ELECTRICAL PARAMETERS MEASUREMENT AND DIAGNOSTIC PROCEDURES 9

Measurement of blood pressure - Cardiac output - Heart rate - Heart sound - Pulmonary function measurements – spirometer – Photo Plethysmography, Body Plethysmography – Blood Gas analysers, pH of blood –measurement of blood pCO2, pO2, finger-tip oxymeter - ESR, GSR measurements.

UNIT – III ELECTRICAL PARAMETERS ACQUISITION AND ANALYSIS 9

Electrodes – Limb electrodes –floating electrodes – pregelled disposable electrodes - Micro, needle and surface electrodes – Amplifiers, Preamplifiers, differential amplifiers, chopper amplifiers – Isolation amplifier - ECG – EEG – EMG – ERG – Lead systems and recording methods – Typical waveforms - Electrical safety in medical environment, shock hazards – leakage current-Instruments for checking safety parameters of biomedical equipment.

UNIT – IV IMAGING MODALITIES AND ANALYSIS 9

Radio graphic and fluoroscopic techniques – Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography –Different types of biotelemetry systems - Retinal Imaging – Imaging application in Biometric systems.

UNIT – V LIFE ASSISTING, THERAPEUTIC AND ROBOTIC DEVICES 9

Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators – Diathermy – Heart – Lung machine – Audio meters – Dialysers – Lithotripsy – Laser therapeutic for eye - Robotic surgery –Orthopaedic prostheses fixation – Tele medicine

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Leslie Cromwell, “Biomedical Instrumentation and Measurement”, Prentice Hall of India, 2018.
2. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw-Hill, 2nd edition, 2014.

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, 4thEdition, Boca Raton, CRC Press LLC, 2015.

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

Course Name :BIOMEDICAL INSTRUMENTATION												**Course Code :20EEV66**			
CO	**Course Outcomes**											**Unit**	**K-CO**	**POs**	**PSOs**
C4V66.1	Explain the philosophy of the heart, lung, blood circulation and respiration system.											1	K2	1,2	-
C4V66.2	Describe the concept of measurement of non-electrical parameters.											2	K2	1,2	-
C4V66.3	Explain the various sensing and measurement devices of electrical origin.											3	K2	1,2	-
C4V66.4	Describe the importance of electrical safety in various biomedical device.											3	K2	1,2	-
C4V66.5	Explain the construction and working of imaging device and their analysis.											4	K2	1,2	-
C4V66.6	Explain the working of medical assistance/techniques, robotic and therapeutic equipment's.											5	K2	1,2	-
CO-PO mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	
C4V66.1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	
C4V66.2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	
C4V66.3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	
C4V66.4	2	1	-	-	-	-	-	-	-	-	-	-	-	-	
C4V66.5	2	1	-	-	-	-	-	-	-	-	-	-	-	-	
C4V66.6	2	1	-	-	-	-	-	-	-	-	-	-	-	-	

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

PRE-REQUISITE:

Course Code: 20BS103
Course Name: Engineering Chemistry

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:

Course Name : ENERGY STORAGE SYSTEMS										**Course Code :20EEV76**				
CO	**Course Outcomes**									**Unit**	**K-CO**	**POs**	**PSOs**	
C4V76.1	Explain the different types of storage technologies									1	K2	1,2	1	
C4V76.2	Describe the thermal storage system									2	K2	1,2	1	
C4V76.3	Summarize the thermodynamics of fuel cell									3	K2	1,2	1	
C4V76.4	Discuss the faulty component in a machine by analyzing theacquired vibration signals L2.									4	K2	1,2	1	
C4V76.5	Explain the appropriate storage technologies for different applications									5	K2	1,2	1	
C4V76.6	Describe the alternate energy storage technologies.									5	K2	1,2	1	
CO-PO mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C4V76.1	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C4V76.2	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C4V76.3	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C4V76.4	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C4V76.5	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C4V76.6	2	1	-	-	-	-	-	-	-	-	-	-	2	-

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:

Course Name :PROBABILITY AND STATISTICS												**Course Code : 20EEV86**			
CO	**Course Outcomes**											**Unit**	**K – CO**	**POs**	**PSOs**
C4V86.1	Build the parameters of statistical distributions using basicprobability theory concepts.											1	K3	1,2,3,8,9	-
C4V86.2	Calculate the statistical measures for two dimensional randomvariables.											2	K3	1,2,3,8,9	-
C4V86.3	Apply the concepts of testing of hypothesis for large samples.											3	K3	1,2,3,8,9	-
C4V86.4	Apply t-test, chi-square and F- Test for small samples.											3	K3	1,2,3,8,9	-
C4V86.5	Apply the basic concepts of design of experiments in the field of agriculture.											4	K3	1,2,3,8,9	-
C4V86.6	Use control charts for quality control problems.											5	K3	1,2,3,8,9	-
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**		**PSO1**	**PSO2**
C4V86.1	3	2	1	-	-	-	-	1	**1**	-	-	-		-	-
C4V86.2	3	2	1	-	-	-	-	1	1	-	-	-		-	-
C4V86.3	3	2	1	-	-	-	-	1	1	-	-	-		-	-
C4V86.4	3	2	1	-	-	-	-	1	1	-	-	-		-	-
C4V86.5	3	2	1	-	-	-	-	1	1	-	-	-		-	-
C4V86.6	3	2	1	-	-	-	-	1	1	-	-	-		-	-

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. Besterfiled, et at., "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:

Course Name : Total Quality Management		**Course Code :** 20HS7A2			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Explain basic concepts, TQM framework, Barriers Benefits of TQM and importance of customers	1	K2	1,5,6,8 -12	
CO2	Explain the TQM Principles, understand the importance of employee involvement and supplier partnership	2	K2	1,5, 6,8 -12	
CO3	Explain the basics of Six Sigma, Traditional tools, New tools ,	3	K2	1,5,6,8 -12	
CO4	Explain the process of Benchmarking and FMEA.	3	K2	1,5,6,8 -12	
CO5	Explain process capability, QFD, TPM, Taguchi quality loss function and performance measures	4	K2	1,5,6,8 -12	
CO6	Explain the Quality system ISO 9000, ISO 14000, Audit, Certification process and implementation of TQM in manufacturing and service sectors	5	K2	1,6,7,8-12	

CO-PO Mapping

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1				1	2		2	2	2	2	1			
CO2	1				2	2		2	2	2	2	1			
CO3	1				2	2		2	2	2	2	1			
CO4	1				2	2		2	2	2	2	1			
CO5	1				2	2		2	2	2	2	1			
CO6	1				-	2	2	2	2	2	2	1			

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 an career option.
    - R & D IP Counsel
    - Government Jobs – Patent Examiner
    - Private Jobs
    - Patent agent and Trademark agent
    - Entrepreneur

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/)

Course Name : Intellectual Property Rights		**Course Code :** 20HS6A1			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Explain the fundamental aspects of Intellectual property Rights which plays a major role in development and management of innovative projects in industries	1		6,7,8,10,11, 12	
CO2	Describe the patents, patent regime in India and abroad and registration aspects.	2		6,7,8,10,11, 12	
CO3	Describe the copyrights and its related rights and registration aspects.	3	K2	6,7,8,10,11, 12	
CO4	Explain the trademarks and registration aspects.	4	K2	6,7,8,10,11, 12	
CO5	Explain the Design, Geographical Indication (GI), Plant Variety and Layout Design Protection and their registration aspects.	5	K2	,8,10,11,12	
CO6	Analyze the current trends in IPR and Government steps in fostering IPR.	5	K2	,8,10,11,12	

CO-PO Mapping

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1						1	1	1		1	1	1			
CO2						1	1	1		1	1	1			
CO3						1	1	1		1	1	1			
CO4						1	1	1		1	1	1			
CO5						1	1	1		1	1	1			
CO6						1	1	1		1	1	1			

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 Clellend'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:

Course Name : Project Management and Entrepreneurship				**Course Code :** 20HS6B1			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**		
CO1	nclude the project characteristics and various stages of a project.	1	K6	8,9,10,11			
CO2	mpile the conceptual clarity about project organization and feasibility.	2	K5	8,9,10,11			
CO3	ply the risk management plan and analyze the role of stakeholders.	3	K3	8,9,10,11			
CO4	alyze the social responsibility for an entrepreneurship.	4	K4	7,8,9,10,11			
CO5	erpret the gain knowledge to overcome the factors affecting small-scale business.	4	K3	8,9,10,11			
CO6	Formulate a new small-scale business.	5	K6	7,8,9,10,11			

CO-PO Mapping

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1								2	2	2	3			
CO2								2	2	2	3			
CO3								2	2	2	3			
CO4							3	2	2	2	3			
CO5								2	2	2	3			
CO6							3	2	2	2	3			

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:

Course Name : Human Relations at Work		Course Code : 20HS8A1			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Implement the elements of Emotional Intelligence and create a plan for continual improvement.	1	K3	6,8,9,10	
CO2	Demonstrate the elements of teamwork such as team development stages, leadership skills, team dynamics, problems solving and decision making approaches, and team building.	2	K3	6,8,9,10	
CO3	Employ active listening skills including paraphrasing, questioning, empathetic listening, analytic listening, responding and communicating non-verbally while respecting individual differences.	2	K3	6,8,9,10	
CO4	Identify various Yoga Postures.	3	K3	6,8,9,10	
CO5	Develop an action plan to increase personal motivation in a personal and or workplace situation.	4	K3	6,8,9,10	
CO6	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.	5	K3	6,8,9,10	

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3											
CO2	3	3	3	3											
CO3	3	3	3	3											
CO4	3	3	3	3											
CO5	3	3	3	3											
CO6	3	3	3	3											

20HS8B2	ECONOMICS FOR ENGINEERS	L	T	P	C
		3	0	0	3

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:

Course Name : ECONOMICS FOR ENGINEERS		Course Code : 20HS8B2			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
CO1	Describe the concept of engineering economics	1	K2	1,2,8	1,2
CO2	Comprehend macroeconomic principles	2	K2	1,2,8	1,2
CO3	Decision making in diverse business set up	3	K2	1,2,8	1,2
CO4	Explain the Inflation & Price Change	3	K2	1,2,8	1,2
CO5	Explain Present Worth Analysis	4	K2	1,2,8	1,2
CO6	Apply the principles of economics through various case studies	5	K3	1,2,3,8	1,2

CO-PO mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1				1	1	2	2	2			1	1
CO2	2	1				1	1	2	2	2			1	1
CO3	2	1				1	1	2	2	2			1	1
CO4	2	1				1	1	2	2	2			1	1
CO5	2	1				1	1	2	2	2			1	1
CO6	2	1				1	1	2	2	2	2		1	1

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 - Defintion 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 Communication - Measures to overcome communication barriers

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.
2. Understand and explain all the managerial functions.
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.
4. Analyze the complexities associated with management of the group behavior in the organization.
5. Demonstrate how the organizational behavior can integrate in understanding the motivation (why) behind behavior of people in the organization.
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.

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, AshishBajpai, Principles of Management, Tata McGraw Hill,

20HS5A2	INDUSTRIAL MARKETING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the basics of Industrial Marketing.
- To know about the Management of Industrial Marketing
- To understand the methods of Strategic Planning and Implementation process.
- To learn the process of Logistics, Marketing Control and Channel Optimization
- To understand the techniques of Pricing and Sales Force Planning

PRE-REQUISITE:NIL

UNIT-I **Basics of Industrial Marketing** **9**

Introduction to Industrial Marketing- Industrial versus Consumer Marketing- Economics of Industrial Demand Classification of Industrial Customers- Unique Characteristics of Organizational Procurement-Purchasing in Government Units

UNIT-II **Management of Industrial Marketing** **9**

Industrial Buying Behaviour in Indian context- Conceptualization of Buying Behavior-Stages in Buying Uncertainty Management in Industrial Marketing- Purchasing Agents in Industrial Buying-Negotiation in Industrial Marketing

UNIT - III **Strategic Planning and Implementation** **9**

Process of Strategic Planning-Macro and Micro Variables Used to Segment Industrial Marketing-Managing the Development of Strategic Planning- Understanding Strategy Formulation and Strategy Implementation Industrial Marketing Strategy Components - Industrial Marketing Research for New Product Development Industrial Marketing Strategy in India.

UNIT - IV **Logistics, Marketing Control and Channel Optimization** **9**

Marketing Logistics- Physical Distribution and Customer Services- Marketing Control Channel Participants-Channel Functions and Dual Channels-Choosing the Right Distributor- Distribution and Manufacturers' Representatives

UNIT - V **Pricing and Sales Force Planning** **9**

Price: A Crucial Element in Product Strategy- The nature of Derived Demand- Segregation of New Product Cost- Pricing in Industrial Marketing- Segregation of New Product Cost - Industrial Product Pricing in India Development of Industrial Sales Force-Motivation of Sales Force- Effective Use of Sales Compensation

TOTAL: 45 PERIODS

OUTCOMES:

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

- Compare industrial vs consumer marketing and the classifications of industrial customers.
- Develop Negotiation and buying techniques for industrial products .
- Formulate strategic plan and implementation methods.
- Develop techniques of Logistics, Marketing Control and Channel Optimization
- Identify Pricing tactics and Sales Force Planning techniques
- Manage the entire industrial marketing process.

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