K.L.N. COLLEGE OF ENGINEERING

Pottapalayam – 630 612, Sivagangai District

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

Estd: 1994

THIRD YEAR CURRICULUM AND SYLLABUS

REGULATIONS 2020

For Under Graduate Program

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM

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

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 Entrepreneurshipand to nurture their character with social concern and to pursue their career in the areas of Research and Industry**.**

VISION OF THE DEPARTMENT

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

MISSION OF THE DEPARTMENT

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

K.L.N. COLLEGE OF ENGINEERING, POTTAPALAYAM

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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 projectsand 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 V

S. NO	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20EE501	Power System Analysis	PC	4	3	1	0	4
2.	20EE502	Power Electronics	PC	3	3	0	0	3
3.	20EE503	Digital Signal Processing	PC	4	3	1	0	4
4.	20EE504	Control Systems	PC	4	3	1	0	4
5.	20EE505	Microprocessors, Microcontrollers and Applications	PC	3	3	0	0	3
6.		Professional Elective-I	PE	3	3	0	0	3
7.	20MC501	Constitution of India	MC	1	1	0	0	0
PRACTICAL								
8.	20EE5L1	Control and Instrumentation Laboratory	PC	3	0	0	3	1.5
9.	20EE5L2	Microprocessors and Microcontrollers Laboratory	PC	3	0	0	3	1.5
10.	20HS4L2	Professional Communication Laboratory	EEC	2	0	0	2	1
TOTAL				**30**	**19**	**3**	**8**	**25**

SEMESTER VI

S. NO	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20EE602	Power System Operation and Control	PC	3	3	0	0	3
2.	20IT301	Object Oriented Programming	ES	3	3	0	0	3
3.		Open Elective-I	OE	3	3	0	0	3
4.		Professional Elective-II	PE	3	3	0	0	3
5.		Professional Elective-III	PE	3	3	0	0	3
6.		Professional Elective –IV	PE	3	3	0	0	3
PRACTICAL								
7.	20EE6L1	Power Electronics and Drives Laboratory	PC	3	0	0	3	1.5
8.	20EE6L2	Mini Project-I	EEC	4	0	0	4	2
9.	20CS6L3	Object Oriented and JAVA Programming Laboratory	ES	3	0	0	3	1.5
TOTAL				**28**	**18**	**0**	**10**	**23**

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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 StateDrives	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,VI and VII. These courses are listed in groups called verticals that represent a particular area of specialization / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester one and another in semester the next semester.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also.

4.10 B.E. / B. Tech. (Hons) Specialisation in the same discipline, B.E. / B. Tech. (Hons) and B.E. / B. Tech. minor in other specialisation.

(i) B.E / B.Tech. Honours

a. The students should have **earned additional courses (minimum of 18 credits) from more than one vertical of the same programme.**

b. Should have passed all the courses in the first attempt.

c. Should have earned a minimum CGPA of 7.50.

(ii) B.E./B.Tech. (minor in other specialisation)

The student should **have earned additionally a minimum of 18 credits in any one of the verticals of other B.E/B.Techprogrammes**

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B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL – I: MODERN POWER SYSTEM ENGINEERING

S. NO	COURSE CODE	COURSE TITLE	CATE GORY	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 VoltageEngineering	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	CATE GORY	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 VEHICLETECHNOLOGY

S. NO	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
		THEORY						
1.	20EEV13	Power Electronic Converters for Electric Vehicles	PE	3	3	0	0	3
2.	20EEV23	Electric Vehicles and Power Management	PE	3	3	0	0	3
3.	20EEV33	Electric Vehicle Design, Mechanics and Control	PE	3	3	0	0	3
4.	20EEV43	Design of Electric Vehicle Charging System	PE	3	3	0	0	3
5.	20EEV53	Testing of Electric Vehicles	PE	3	3	0	0	3
6.	20EEV63	Grid Integration of Electric Vehicles	PE	3	3	0	0	3
7.	20EEV73	Intelligent control of Electric Vehicles	PE	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	CATE GORY	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	CATE GORY	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	CATE GORY	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/ 20CS8B4	Block Chain Technology	PE	3	3	0	0	3
4.	20EEV46	Data Structures and Algorithms	PE	3	3	0	0	3
5.	20EEV56	Soft Computing	PE	3	3	0	0	3
6.	20EEV66	Biomedical Instrumentation	PE	3	3	0	0	3
7.	20EEV76	Energy Storage Systems	PE	3	3	0	0	3
8.	20EEV86	Probability And Statistics	PE	3	3	0	0	3

OPEN ELECTIVE – I (VI SEMESTER)

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

Enrollment 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 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, Moreover, for minor degree the student can register for courses from any one of the following verticals also. Complete details are available in clause 4.10 (Amendments) of Regulations 2020.

VERTICALS FOR MINOR DEGREE (In addition to all the verticals of other degree programmes)

VERTICAL 1: FINTECH AND BLOCK CHAIN

S. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20MGV11	Financial Management	HS	3	3	0	0	3
2.	20MGV21	Fundamentals of Investment	HS	3	3	0	0	3
3.	20MGV31	Banking, Financial Services and Insurance	HS	3	3	0	0	3
4.	20MGV41	Introduction to Blockchain and its Applications	HS	3	3	0	0	3
5.	20MGV51	Fintech Personal Finance and Payments	HS	3	3	0	0	3
6.	20MGV61	Introduction to Fintech	HS	3	3	0	0	3

VERTICAL 2: ENTREPRENEURSHIP

S. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	20MGV12	Foundations of Entrepreneurship	HS	3	3	0	0	3
2.	20MGV22	Team Building & Leadership Management for Business	HS	3	3	0	0	3
3.	20MGV32	Creativity & Innovation in Entrepreneurship	HS	3	3	0	0	3
4.	20MGV42	Principles of Marketing Management For Business	HS	3	3	0	0	3
5.	20MGV52	Human Resource Management for Entrepreneurs	HS	3	3	0	0	3
6.	20MGV62	Financing New Business Ventures	HS	3	3	0	0	3

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

OBJECTIVES:

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

PRE-REQUISITE:

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

UNIT - I INTRODUCTION 12

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

UNIT - II POWER FLOW ANALYSIS 12

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

UNIT - III FAULT ANALYSIS – BALANCED FAULTS 12

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

UNIT - IV FAULT ANALYSIS – UNBALANCED FAULTS 12

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

UNIT - V STABILITY ANALYSIS 12

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

TOTAL: 60 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

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

Course Name : POWER SYSTEM ANALYSIS												**Course Code : 20EE501**			
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSOs**
C301.1	Apply the mathematical and engineering knowledge to form bus admittance matrix and impedance matrix											I	K3	1,2,3	1,2
C301.2	Apply Gauss-Seidel and Newton Raphson methods to solve the load flow problem											II	K3	1,2,3	1,2
C301.3	Analyze the power system under steady state symmetrical fault											III	K4	1,2,3,4	1,2
C301.4	Analyze the power system under unsymmetrical faults											IV	K4	1,2,3,4	1,2
C301.5	Analyze the transient stability of the power system using equal area criterion											V	K4	1,2,3,4	1,2
C301.6	Analyze the transient stability of the power system using swing equation											V	K4	1,2,3,4	1,2
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**		**PSO1**	**PSO2**
C301.1	3	2	1	-	-	-	-	-	-	-	-	-		2	2
C301.2	3	2	1	-	-	-	-	-	-	-	-	-		2	2
C301.3	3	3	2	1	-	-	-	-	-	-	-	-		2	2
C301.4	3	3	2	1	-	-	-	-	-	-	-	-		2	2
C301.5	3	3	2	1	-	-	-	-	-	-	-	-		2	2
C301.6	3	3	2	1	-	-	-	-	-	-	-	-		2	2
C301	3	3	2	1	-	-	-	-	-	-	-	-		2	2

20EE502	POWER ELECTRONICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

PRE-REQUISITE:

Course Code: 20EE302
Course Name: Electron Devices and Circuits

UNIT - I POWER SEMI-CONDUCTOR DEVICES 9

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

UNIT - II PHASE-CONTROLLED CONVERTERS 9

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

UNIT - III DC TO DC CONVERTERS 9

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

UNIT - IV INVERTERS 9

Single phase and three phase voltage source inverters (both120˚ mode and 180˚ mode) – Voltage & harmonic control - PWM techniques: Multiple PWM, Sinusoidal PWM, modified sinusoidal PWM – Introduction to space vector modulation – Current source inverter, Applications - Induction heating, UPS.

UNIT - V AC TO AC CONVERTERS 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

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

Course Name : POWER ELECTRONICS											**Course Code : 20EE502**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C302.1	Explain the significance of switching devices and its application to power converters and its characteristics										I	K2	1,2	1
C302.2	Apply the knowledge of engineering fundamentals to derive the performance parameters of 2 pulse, 3 pulse and 6 pulse converter										II	K3	1,2,3	1
C302.3	Apply the knowledge of engineering fundamentals to derive the performance analysis of Buck, Boost, Buck-Boost converters										III	K3	1,2,3	1
C302.4	Explain the operation of single phase and three phase Voltage Source Inverters and Current Source Inverters										IV	K2	1,2	1
C302.5	Explain the operation of single & three phase AC Voltage controllers										V	K2	1,2	1
C302.6	Explain the operation of single & three phase Cyclo converters										V	K2	1,2	1
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C302.1	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C302.2	3	2	1	-	-	-	-	-	-	-	-	-	2	-
C302.3	3	2	1	-	-	-	-	-	-	-	-	-	2	-
C302.4	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C302.5	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C302.6	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C302	3	1	1	-	-	-	-	-	-	-	-	-	2	-

20EE503	DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	1	0	4

OBJECTIVES:

To impart knowledge on

- Classification of signals and systems & their mathematical representation.
- Analysis of discrete-time systems using different types of transforms.
- Computation of Discrete Fourier Transform using FFT algorithm.
- Design of IIR and FIR digital filters using impulse invariant and bilinear transformation techniques and using various window functions.
- Architecture of digital signal processor.

PRE-REQUISITE:

Course Code: 20BS301

Course Name: Transforms and Partial Differential Equations

UNIT – I INTRODUCTION TO SIGNALS AND SYSTEMS 12

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

UNIT – II DISCRETE TIME SYSTEM ANALYSIS 12

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

UNIT - III DISCRETE FOURIER TRANSFORM & COMPUTATION 12

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

UNIT - IV DESIGN OF DIGITAL FILTERS 15

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

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

UNIT - V DIGITAL SIGNAL PROCESSORS 9

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

TOTAL: 60 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

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

Course Name : DIGITAL SIGNAL PROCESSING											**Course Code : 20EE503**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C303.1	Identify the type of given discrete time signals and systems.										I	K3	1,2,3	1
C303.2	Apply Z-transform to analyze the given discrete time systems.										II	K3	1,2,3	1
C303.3	Apply FFT algorithm to compute DFT.										III	K3	1,2,3	1
C303.4	Design IIR filter using impulse invariant and bilinear transformation techniques for the given specifications.										IV	K3	1,2,3	1
C303.5	Design FIR filter using windowing techniques (Rectangular, Hamming and Hanning) for the given specifications.										IV	K3	1,2,3	1
C303.6	Explain the architecture of digital signal processors and its addressing modes.										V	K2	1,2	1
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C303.1	3	2	1	-	-	-	-	-	-	-	-	-	2	-
C303.2	3	2	1	-	-	-	-	-	-	-	-	-	2	-
C303.3	3	2	1	-	-	-	-	-	-	-	-	-	2	-
C303.4	3	2	1	-	-	-	-	-	-	-	-	-	2	-
C303.5	3	2	1	-	-	-	-	-	-	-	-	-	2	-
C303.6	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C303	3	2	1										2	

20EE504	CONTROL SYSTEMS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To understand the use of transfer function models to analyze physical systems.
- To provide adequate knowledge in the time response of systems and steady state error analysis.
- To accord basic knowledge in obtaining the open loop and closed–loop frequency responses of systems.
- To introduce stability analysis and design of compensators.
- To introduce state variable representation of physical systems.

PRE-REQUISITE:

Course Code: 20EE201, 20BS301
Course Name: Electric Circuit Analysis, Transforms and Partial Differential Equations

UNIT - I SYSTEMS AND REPRESENTATION 12

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

UNIT - II TIME RESPONSE ANALYSIS 12

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

UNIT - III FREQUENCY RESPONSE ANALYSIS 12

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

UNIT - IV CONCEPTS OF STABILITY ANALYSIS 12

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

UNIT - V STATE VARIABLE ANALYSIS 12

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

TOTAL: 60 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

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

Course Name : CONTROL SYSTEMS												Course Code : 20EE504			
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSOs**
C304.1	Apply the knowledge of mathematics, Engineering fundamentals to develop mathematical models for physical system and simplify it using reduction techniques.											I	K3	1,2,3	1
C304.2	Apply the knowledge of mathematics, Engineering fundamentals to compute the time domain responses of first and second-order systems to test inputs.											II	K3	1,2,3	1
C304.3	Analyze the stability of the system using different frequency domain methods.											III	K4	1,2,3,4	1
C304.4	Design the compensators and their selection to meet desired response.											III	K4	1,2,3,4	1
C304.5	Analyze the behavior of closed loop systems using tools such as Root locus technique, Routh Hurwitz and Nyquist Criteria											IV	K4	1,2,3,4	1
C304.6	Apply the knowledge of mathematics, Engineering fundamentals to develop state space models.											V	K3	1,2,3	1
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	
C304.1	3	2	1	-	-	-	-	-	-	-	-	-	2	-	
C304.2	3	2	1	-	-	-	-	-	-	-	-	-	2	-	
C304.3	3	3	2	1	-	-	-	-	-	-	-	-	2	-	
C304.4	3	3	2	1	-	-	-	-	-	-	-	-	2	-	
C304.5	3	3	2	1	-	-	-	-	-	-	-	-	2	-	
C304.6	3	3	1	-	-	-	-	-	-	-	-	-	2	-	
C304	3	3	1	1	-	-	-	-	-	-	-	-	2	-	

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

OBJECTIVES:

- To understand the Architecture of 8086 microprocessor.
- To develop skills in simple program writing in assembly languages
- To introduce commonly used peripheral/ interfacing ICs.
- To study and understand typical applications of micro-processors.
- To study and understand the typical applications of micro-controllers

PRE-REQUISITE:

Course Code: 20EE301.
Course Name: Digital Logic Circuits.

UNIT - I INTRODUCTION TO 8086 MICROPROCESSOR 9

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

UNIT - II 8086 SYSTEM BUS STRUCTURE 9

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

UNIT - III INTERFACING BASICS AND ICS 9

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

UNIT - IV INTRODUCTION TO 8051 MICROCONTROLLER 9

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

UNIT - V INTRODUCTION TO ADVANCED ARCHITECTURE 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

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

Course Name : Microprocessors, Microcontrollers And Applications												**Course Code : 20EE505**			
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSOs**
C305.1	Develop and execute programs in 8086 microprocessor.											I	K3	1,2,3	1
C305.2	Explain the System Bus structure of 8086 microprocessor.											II	K2	1,2	1
C305.3	Illustrate the interfacing of peripheral with microprocessor and microcontroller											III	K2	1,2	1
C305.4	Explain the architecture and Interrupt structure of 8051.											III	K2	1,2	1
C305.5	Design microcontroller based Temperature control and stepper motor control system.											IV	K3	1,2,3	1
C305.6	Explain the architecture of ARM processor.											V	K2	1,2	1
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**		**PSO1**	**PSO2**
C305.1	3	2	1	-	-	-	-	-	-	-	-	-		2	-
C305.2	2	1	-	-	-	-	-	-	-	-	-	-		1	-
C305.3	2	1	-	-	-	-	-	-	-	-	-	-		1	-
C305.4	2	1	-	-	-	-	-	-	-	-	-	-		1	-
C305.5	3	2	1	-	-	-	-	-	-	-	-	-		2	-
C305.6	2	1	-	-	-	-	-	-	-	-	-	-		1	-
C305	2	1	1	-	-	-	-	-	-	-	-	-		1	-

20MC501	CONSTITUTION OF INDIA	L	T	P	C
		1	0	0	0

OBJECTIVES:

- To enable the student to understand the importance of the constitution.
- To understand the structure of executive, legislature, and judiciary.
- To understand the philosophy of fundamental rights, duties and Emergency Provisions.
- To understand the autonomous nature of constitutional bodies like Supreme Court and high court.
- To understand the central and state relation financial and administrative.

PRE-REQUISITE: NIL

UNIT-I INTRODUCTION 3

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

UNIT-II CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES 3

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

UNIT - III ORGANS OF GOVERNANCE 3

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

UNIT - IV EMERGENCY PROVISIONS 3

Emergency Provisions - National Emergency, President Rule, Financial Emergency

UNIT - V LOCAL ADMINISTRATION 3

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

TOTAL: 15 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

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

Course Name : CONSTITUTION OF INDIA											**Course Code : 20MC501**				
CO	**Course Outcomes**							**Unit**	**K-CO**	**POs**			**PSOs**		
C307.1	Explain history and philosophy of Indian Constitution.							I	K2	6,8,9,10			-		
C307.2	Explain the premises informing the twin themes of liberty and freedom from a civil rights perspective.							II	K2	6,8,9,10			-		
C307.3	Explain the powers and functions of Indian government							III	K2	6,8,9,10			-		
C307.4	Explain the emergency rules of Indian Constitution.							IV	K2	6,8,9,10			-		
C307.5	Explain the structure and functions of local administration.							V	K2	6,8,9,10			-		
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C307.1	-	-	-	-	-	3	-	2	2	2	-	-	-	-	-
C307.2	-	-	-	-	-	3	-	2	2	2	-	-	-	-	-
C307.3	-	-	-	-	-	3	-	2	2	2	-	-	-	-	-
C307.4	-	-	-	-	-	3	-	2	2	2	-	-	-	-	-
C307.5	-	-	-	-	-	3	-	2	2	2	-	-	-	-	-
C307.1	-	-	-	-	-	3	-	2	2	2	-	-	-	-	-

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

OBJECTIVES:

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

PRE-REQUISITE:

Course Code: 20EE2L2
Course Name: Electric Circuits Laboratory

LIST OF EXPERIMENTS:

CONTROLSYSTEMS:

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

INSTRUMENTATION:

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

TOTAL: 45 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

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

OUTCOMES:

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

Course Name : CONTROL AND INSTRUMENTATION LABORATORY												Course Code : 20EE5L1			
CO	**Course Outcomes**											**Exp**	**K –CO**	**POs**	**PSOs**
C307.1	Analyze the characteristics of P, PI and PID controllers experimentally and analyze the stability of the control system using MATLAB.											1,2	K4	1,2,3,4, 9	1
C307.2	Compute the transfer function of a Field controlled DC motor experimentally and analyze the response of Lag, Lead and Lag-Lead Compensators.											3,4	K3	1,2,3,9	1
C307.3	Analyze the transient response of Position Control system experimentally and analyze the Characteristics of Synchro -Transmitter-Receiver.											5,6	K4	1,2,3,4, 9	1
C307.4	Use MATLAB for the Simulation of Control Systems.											7	K3	1,2,3,9	1
C307.5	Analyze the basic concepts of bridge networks and to analyze the Dynamics of Sensors/Transducers.											8,9	K4	1,2,3,4, 9	1
C307.6	Measure the Power and Energy experimentally and analyze signal conditioning circuits.											10,11	K4	1,2,3,4, 9	1
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**		**PSO1**	**PSO2**
C307.1	3	3	2	1		-	-	-	**2#**	-	-	-		2	-
C307.2	3	2	1	-	**-**	-	-	-	**2#**	-	-	-		2	-
C307.3	3	3	2	1	-	-	-	-	**2#**	-	-	-		2	-
C307.4	3	2	1	-	-	-	-	-	**2#**	-	-	-		2	-
C307.5	3	3	2	1	-	-	-	-	**2#**	-	-	-		2	-
C307.6	3	3	2	1	-	-	-	-	**2#**	-	-	-		2	-

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

OBJECTIVES:

- To perform simple arithmetic operations using assembly language program and study the addressing modes & instruction set of 8086 & 8051.
- To write an assembly language program to convert Analog input to Digital output and Digital input to Analog output.
- To perform interfacing experiments with µP8086.

PRE-REQUISITE:

Course Code: 20EE301.
Course Name: Digital Logic Circuits.

LIST OF EXPERIMENTS:

8086 Programs using kits:

1. Basic arithmetic and Logical operations.
2. Move a data block without overlap.
3. Code conversion, decimal arithmetic and Matrix operations.
4. Floating point operations, string manipulations, sorting and searching.
5. Counters and Time Delay.

Peripherals and Interfacing Experiments:

6. Traffic light controller.
7. Stepper motor control.
8. Key board and Display.
9. Serial interface and Parallel interface.
10. A/D and D/A interface and Waveform Generation.

8051 Experiments using kits:

11. Basic arithmetic and Logical operations.
12. Square and Cube program, Find 2‘s complement of a number.

TOTAL: 45 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

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

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

Course Name : Microprocessors And Microcontrollers Laboratory											Course Code : 20EE5L2			
CO	**Course Outcomes**										**Exp**	**K –CO**	**POs**	**PSOs**
C308.1	Develop an assembly language program for arithmetic, Logical operations using 8086 processor also Move a data block without overlap.										1,2	K3	1,2,3,5,6,9	1,2
C308.2	Develop program for code conversion, decimal arithmetic, Matrix operations and Floating point operations.										3,4	K3	1,2,3,5,6,9	1,2
C308.3	Develop program for Counters and Time Delay and Traffic light controller.										5,6	K3	1,2,3,5,6,9	1,2
C308.4	Develop programs for serial communication and Stepper motor control										7,8	K3	1,2,3,5,6,9	1,2
C308.5	Demonstrate the program of Serial interface, Parallel interface, A/D, D/A interface and Waveform Generation										9,10	K3	1,2,3,5,6,9	1,2
C308.6	Develop an assembly language program for arithmetic, Logical operations, Square and Cube program, Find 2's complement of a number using 8051 microcontroller.										11,12	K3	7,8,10,11	2
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C308.1	3	2	1	**-**	1	1	-	-	2	-	-	-	2	1
C308.2	3	2	1	**-**	1	1	-	-	2	-	-	-	2	1
C308.3	3	2	1	**-**	1	1	-	-	2	-	-	-	2	1
C308.4	3	2	1	**-**	1	1	-	-	2	-	-	-	2	1
C308.5	3	2	1	-	1	1	-	-	2	-	-	-	2	1
C308.6	-	-	-	-	-	-	**2#**	**2#**	-	**2#**	**2#**	-	-	1

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

OBJECTIVES:

- This course is framed for imparting practical approach in learning and enhancing communication skill among engineering students.
- Students will be able to identify appropriate expressions in speaking and writing.
- Students will also be able to understand this style and perfection of language in reading and listening various contexts of engineering and technology.
- The course will benefit to the students to gain confidence for every day communication, technical presentation, aptitude test and interviews.

PRE-REQUISITE:

Course Code: 20HS101
Course Name: English for Technical Communication

UNIT I LISTENING 6

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

UNIT II SPEAKING 6

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

UNIT III READING 6

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

UNIT IV WRITING 6

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

UNIT V SUMMARIZED ACTIVITIES 6

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

TOTAL: 30 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

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

Course Name : PROFESSIONAL COMMUNICATION LABORATORY												Course Code : 20HS4L2			
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSOs**
C309.1	Express ideas and concepts on par global communication											1,2	K3	9,10,12	-
C309.2	Involve inter-personal communication with flair and error-free verbatim											3,4	K3	9,10,12	-
C309.3	Face interviews confidently and respond in proper language ability											5,6	K3	9,10,12	-
C309.4	Participate in group discussion and share innovative ideas in technical environments											7,8	K3	9,10,12	-
C309.5	Adapt multi-national exposure on employment											9,10	K3	9,10,12	-
C309.6	Master all-round competency in delivering apt communication for employability											1-10	K3	9,10,12	-
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**		**PSO1**	**PSO2**
C309.1	-	-	-	-	-	-	-	-	2	3	-	3		-	-
C309.2	-	-	-	-	-	-	-	-	2	3	-	3		-	-
C309.3	-	-	-	-	-	-	-	-	3	3	-	3		-	-
C309.4	-	-	-	-	-	-	-	-	2	3	-	3		-	-
C309.5	-	-	-	-	-	-	-	-	3	3	-	3		-	-
C309.6	-	-	-	-	-	-	-	-	2	3	-	3		-	-

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

OBJECTIVES:

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

PRE-REQUISITE:

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

UNIT-I INTRODUCTION 9

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

UNIT-II REAL POWER - FREQUENCY CONTROL 9

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

[

UNIT-III REACTIVE POWER–VOLTAGE CONTROL 9

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

UNIT- IV UNIT COMMITMENT AND ECONOMIC DISPATCH 9

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

UNIT-V COMPUTER CONTROL OF POWER SYSTEMS 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

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

Course Name : POWER SYSTEM OPERATION AND CONTROL											**Course Code : 20EE602**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C310.1	Apply electrical engineering knowledge to calculate the values of load distribution parameters.										I	K3	1,2,3	1,2
C310.2	Analyze the modeling for two area control system with and without controller										II	K4	1,2,3,4	1,2
C310.3	Explain various types of excitation system and derive the modeling of AVR										III	K2	1,2	1,2
C310.4	Solve the Unit Commitment problems using priority method										IV	K3	1,2,3	1,2
C310.5	Solve the Economic Dispatch problems										IV	K3	1,2,3	1,2
C310.6	Explain the data acquisition and control in power systems and to analyze the contingency of power system										V	K3	1,2,3	1,2
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C310.1	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C310.2	3	3	2	1	-	-	-	-	-	-	-	-	3	2
C310.3	2	1	-	-	-	-	-	-	-	-	-	-	1	1
C310.4	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C310.5	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C310.6	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C310	3	2	1	-	-	-	-	-	-	-	-	-	2	2

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

OBJECTIVES:

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

PRE-REQUISITE:

Course code : 20CS201
Course Name : Programming in C

UNIT-I INTRODUCTION TO OOP AND JAVA FUNDAMENTALS 9

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

UNIT-II INHERITANCE AND INTERFACES 9

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

UNIT-III EXCEPTION HANDLING AND I/O 9

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

UNIT-IV MULTITHREADING AND GENERIC PROGRAMMING 9

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

UNIT-V EVENT DRIVEN PROGRAMMING 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

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

Course Name : OBJECT ORIENTED PROGRAMMING											Course Code : 20IT301			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C311.1	Realize the Object-Oriented Programming concepts and Basics of java Programming tool.										I	K3	1,2,3	1
C311.2	Apply the concepts of inheritance and interfaces using java programs										II	K3	1,2,3	1
C311.3	Construct java exceptions and I/O streams										III	K3	1,2,3	1
C311.4	Illustrate multithread concepts and generics in java										IV	K3	1,2,3	1
C311.5	Design and develop interactive java application using AWT										V	K3	1,2,3	1
C311.6	Design and develop interactive java application using Swing										V	K3	1,2,3	1
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C311.1	3	2	1	-	-	-	-	-	-	-	-	-	3	-
C311.2	3	2	1	-	-	-	-	-	-	-	-	-	3	-
C311.3	3	2	1	-	-	-	-	-	-	-	-	-	3	-
C311.4	3	2	1	-	-	-	-	-	-	-	-	-	3	-
C311.5	3	2	1	-	-	-	-	-	-	-	-	-	3	-
C311.6	3	2	1	-	-	-	-	-	-	-	-	-	3	-

20EE6L1	POWER ELECTRONICS AND DRIVES LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

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

PRE-REQUISITE:

Course Code: 20EE3L1
Course Name: Electronics Laboratory

LIST OF EXPERIMENTS:

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

TOTAL: 45 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

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

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

Course Name : Power Electronics And Drives Laboratory													Course Code : 20EE6L1	
CO	**Course Outcomes**												**Exp**	**K –CO**	**POs**	**PSOs**
C316.1	Conduct on experiment to generate the gate pulse of SCR using R, RC and UJT triggering circuit and differentiate the VI characteristics of power electronics devices.												1,2, 3	K3	1,2,3,9	1,2
C316.2	Conduct on experiment to analyze the performance of the designed single phase AC to DC semi converter and fully controlled converter with R and RL load using MATLAB simulation tool.												4,5	K4	1,2,3,4,9	1,2
C316.3	Conduct on experiment to analyze the performance of the designed step down and step up MOSFET based choppers using MATLAB simulation tool.												6	K4	1,2,3,4,9	1,2
C316.4	Conduct on experiment to analyze the performance of the designed AC –AC converters and Switched mode power converter using MATLAB simulation tool.												7,8	K4	1,2,3,4,9	1,2
C316.5	Conduct on experiment to show the frequency response of single phase PWM inverter and inverter fed induction motor drive.												9,10	K3	1,2,3,9	1,2
C316.6	Demonstrate the speed control of the given Micro controller based DC drive by conducting suitable experiment.												11	K3	1,2,3,9	1,2
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**		
C316.1	3	2	1	-	-	-	-	-	2#	-	-	-	2	2		
C316.2	3	3	2	1	1	-	-	-	2#	-	-	-	2	2		
C316.3	3	3	2	1	1	-	-	-	2#	-	-	-	2	2		
C316.4	3	3	2	1	1	-	-	-	2#	-	-	-	2	2		
C316.5	3	2	1	-	-	-	-	-	2#	-	-	-	2	2		
C316.6	3	2	1	-	-	-	-	-	2#	-	-	-	2	2		

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

OBJECTIVES:

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

PRE-REQUISITE: NIL

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

TOTAL: 60 PERIODS

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

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

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

Course Name : MINI PROJECT-I												Course Code : 20EE6L2			
CO	**Course Outcomes**											**Exp**	**K –CO**	**POs**	**PSOs**
C317.1	Identify and apply the real world and societal importance problems in the Electrical and its allied area.											-	K4	1-12	1,2
C317.2	Identify, analyze, design, implement and handle prototype projects with a complete and organized solution methodologies											-	K4	1-12	1,2
C317.3	Apply modern engineering tools for solution											-	K4	1-12	1,2
C317.4	Contribute as an individual or in a team in development of technical projects											-	K4	1-12	1,2
C317.5	Develop effective communication skills for presentation of project related activities											-	K4	1-12	1,2
C317.6	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**	
C317.1	3	3	2	1	1	1	1	1	1	1	1	1	2	2	
C317.2	3	3	2	1	1	1	1	1	1	1	1	1	2	2	
C317.3	3	3	2	1	1	1	1	1	1	1	1	1	2	2	
C317.4	3	3	2	1	1	1	1	1	1	1	1	1	2	2	
C317.5	3	3	2	1	1	1	1	1	1	1	1	1	2	2	
C317.6	3	3	2	1	1	1	1	1	1	1	1	1	2	2	

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

OBJECTIVES:

- To build software development skills using java programming for real-world applications.
- To understand and apply the concepts of classes, packages, interfaces, array list, exception handling and file processing.
- To develop applications using generic programming and event handling.

PRE-REQUISITE:

Course code : 20CS201
Course Name : Programming in C

LIST OF EXPERIMENTS:

1. a) Write a Java program that checks whether a given string is a palindrome or not.
   b) Write a Java program for sorting list of names. Read input from command line
2. Develop a Java application to generate Electricity bill. Create a class with the following members: Consumer no., consumer name, previous month reading, current month reading, type of EB connection (i.e domestic or commercial). Compute the bill amount using the following tariff.
   If the type of the EB connection is domestic, calculate the amount to be paid as follows:

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

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

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

3. Develop a java application to implement currency converter (Dollar to INR, EURO to INR, Yen to INR and vice versa), distance converter (meter to KM, miles to KM and vice versa), time converter (hours to minutes, seconds and vice versa) using packages.
4. Develop a java application with Employee class with Emp_name, Emp_id, Address, Mail_id, Mobile_no as members. Inherit the classes, Programmer, Assistant Professor, Associate Professor and Professor from employee class. Add Basic Pay (BP) as the member of all the inherited classes with 97% of BP as DA, 10 % of BP as HRA, 12% of BP as PF, 0.1% of BP for staff club fund. Generate pay slips for the employees with their gross and net salary.
5. Design a Java interface for ADT Stack. Implement this interface using array. Provide necessary exception handling in both the implementations.
6. Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named print Area(). Provide three classes named Rectangle,

Triangle and Circle such that each one of the classes extends the class Shape. Each one of the classes contains only the method print Area () that prints the area of the given shape.

7. Write a Java program to implement user defined exception handling.
8. Write a Java program that reads a file name from the user, displays information about whether the file exists, whether the file is readable, or writable, the type of file and the length of the file in bytes.
9. Write a java program that implements a multi-threaded application that has three threads. First thread generates a random integer every 1 second and if the value is even, second thread computes the square of the number and prints. If the value is odd, the third thread will print the value of cube of the number.
10. Write a java program to find the maximum value from the given type of elements using a generic function.

TOTAL: 45 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

Software Requirement :

- JDK8.0 / Net beans 11

OUTCOMES:

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

Course Name : Object Oriented and Java Programming Laboratory											**Course Code : 20CS6L3**			
CO	**Course Outcomes**										**Exp**	**K –CO**	**POs**	**PSOs**
C318.1	Develop and implement Java programs for simple applications that make use of classes, packages.										1,2	K3	1,2,3,5,8	1,2
C318.2	Develop and implement Java programs with inheritance and interfaces.										3,4	K3	1,2,3,5,8	1,2
C318.3	Develop Java programs to implement function polymorphism.										5,6	K3	1,2,3,5,8	1,2
C318.4	Develop simple java programs with use of files and exceptions.										7,8	K3	1,2,3,5,8	1,2
C318.5	Develop simple java programs by implementing multithread concepts.										9,10	K3	1,2,3,5,8	1,2
C318.6	Develop simple java program by using generic concepts.										11,12	K3	1,2,3,5,8	1,2
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C318.1	3	2	1	-	1	-	-	1	-	-	-	-	3	2
C318.2	3	2	1	-	1	-	-	1	-	-	-	-	3	2
C318.3	3	2	1	-	1	-	-	1	-	-	-	-	3	2
C318.4	3	2	1	-	1	-	-	1	-	-	-	-	3	2
C318.5	3	2	1	-	1	-	-	1	-	-	-	-	3	2
C318.6	3	3	1	-	1	-	-	1	-	-	-	-	3	3

PROFESSIONAL ELECTIVE – I

20EEV11	POWER QUALITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

PRE-REQUISITE: NIL

UNIT - I INTRODUCTION 9

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

UNIT - II VOLTAGE SAGS AND INTERRUPTIONS 9

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

UNIT - III OVERVOLTAGES 9

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

UNIT - IV HARMONICS 9

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

UNIT - V POWER QUALITY MONITORING AND CUSTOM POWER DEVIES 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

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

Course Name : POWER QUALITY											**Course Code : 20EEV11**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C306V1.1	Explain power quality disturbances, their causes, detrimental effects and Power quality standard.										I	K3	1,2,3	1,2
C306V1.2	Describe the impact of voltage sag and interruptions in power systems.										II	K3	1,2,3	1,2
C306V1.3	Analyze the over voltage phenomena using PSCAD and EMTP.										III	K4	1,2,3,4	1,2
C306V1.4	Describe the impact of Harmonics in power systems.										IV	K3	1,2,3	1,2
C306V1.5	Explain the different types of monitoring devices/methods for power quality in power system.										V	K3	1,2,3	1,2
C306V1.6	Discuss the different types of custom power devices for enhancement of power quality in power system.										V	K3	1,2,3	1,2
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C306V1.1	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C306V1.2	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C306V1.3	3	3	2	1	-	-	-	-	-	-	-	-	2	2
C306V1.4	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C306V1.5	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C306V1.6	3	2	1	-	-	-	-	-	-	-	-	-	2	2

20EEV12	MODERN POWER CONVERTERS	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

PRE-REQUISITE: NIL

UNIT - I SWITCHED MODE POWER SUPPLIES (SMPS) 9

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

UNIT - II AC-DC CONVERTERS 9

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

UNIT - III DC-AC CONVERTERS 9

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

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

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

UNIT - V SOFT-SWITCHING POWER CONVERTERS 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

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

Course Name : MODERN POWER CONVERTERS												**Course Code : 20EEV12**		
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C306V2.1	Explain the concepts and working of Switched mode dc power supplies.										I	K3	1,2,3	1,2
C306V2.2	Explain the various AC-DC power converter circuits and their switching techniques.										II	K3	1,2,3	1,2
C306V2.3	Analyze various types of DC-AC power converter circuits.										III	K4	1,2,3,4	1,2
C306V2.4	Design various basic topology of Matrix converter.										IV	K3	1,2,3	1,2
C306V2.5	Compare AC-AC Power converter performance with and without dc link.										IV	K3	1,2,3	1,2
C306V2.6	Describe the operating principle of soft switching power converter and compare various types of Soft Switched Power converters.										V	K3	1,2,3	1,2
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C306V2.1	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C306V2.2	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C306V2.3	3	3	2	1	-	-	-	-	-	-	-	-	2	2
C306V2.4	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C306V2.5	3	3	1	-	-	-	-	-	-	-	-	-	2	2
C306V2.6	3	2	1	-	-	-	-	-	-	-	-	-	2	2

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

OBJECTIVES:

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

PRE-REQUISITE:

Course Code: 20EE302, 20EE304
Course Name: Electron Devices and Circuits, Electrical Machines – I

UNIT - I BASIC POWER ELECTRONIC DEVICES 9

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

UNIT - II DC/DC CONVERTER 9

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

UNIT - III RECTIFIERS AND INVERTERS 9

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

UNIT - IV ELECTRIC MOTOR DRIVES 9

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

UNIT - V CONTROL OF HYBRID AND FUEL CELL VEHICLES 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

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

Course Name : POWER ELECTRONIC CONVERTERS FOR ELECTRIC VEHICLE											Course Code : 20EEV13			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C306V3.1	Explain the basics of various power electronics devices suitable for electric vehicles.										I	K2	1,2	1
C306V3.2	Explain the operation of DC-DC Converters used in electric vehicles										II	K2	1,2	1
C306V3.3	Explain the operation of rectifiers and inverters used in electric vehicles										III	K2	1,2	1
C306V3.4	Explain the various DC motor drives suitable for EV										IV	K2	1,2	1
C306V3.5	Explain the various AC motor drives suitable for EV										IV	K2	1,2	1
C306V3.6	Explain the Electric Propulsion unit of Electric vehicles										V	K2	1,2	1
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C306V3.1	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C306V3.2	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C306V3.3	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C306V3.4	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C306V3.5	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C306V3.6	2	1	-	-	-	-	-	-	-	-	-	-	2	-

20EEV14	EMBEDDED PROCESSORS	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

PRE-REQUISITE:

Course Code: 20EE301.
Course Name: Digital Logic Circuits.

UNIT - I Introduction to Embedded Systems **9**

Understanding embedded system - Overview of basic electronics and digital electronics - Microcontroller & microprocessor - Comparison between the two microcontroller (vs) microprocessor - Common features of microcontroller - Different types of microcontroller.
Introduction to Arduino - Pin configuration and architecture - Device and platform features Concept of digital and analog ports - Familiarizing with Arduino Interfacing Board Introduction to Embedded C and Arduino platform

UNIT - II Review of Basic Concepts of Arduino 9

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

UNIT - III Arduino Displays and Sensors 9

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

UNIT - IV Arduino Secondary Integrations 9

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

UNIT - V Arduino Communications, IOT and Cloud Computing 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

OUTCOMES:

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

Course Name : EMBEDDED PROCESSORS											**Course Code : 20EEV14**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C306V4.1	Understand the basics of Embedded processors and Arduino development boards										I	K2	1,2	1
C306V4.2	Understand the programming concepts of Arduino development kits										II	K2	1,2	1
C306V4.3	Understand the interfacing of display units in Arduino development boards										III	K2	1,2	1
C306V4.4	Understand the interfacing of sensors in Arduino development boards										III	K2	1,2	1
C306V4.5	Understand the interfacing of relays and motors in Arduino development boards										IV	K2	1,2	1
C306V4.6	Understand the interfacing of IoT applications in clouds by using Arduino development boards										V	K2	1,2	1
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C306V4.1	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C306V4.2	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C306V4.3	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C306V4.4	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C306V4.5	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C306V4.6	2	1	-	-	-	-	-	-	-	-	-	-	1	-

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

OBJECTIVES:

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

PRE-REQUISITE: NIL

UNIT-I STATE VARIABLE DESIGN 9

Introduction to state model - effect of state feedback - Necessary and Sufficient Condition for Arbitrary Pole placement - pole placement design - Design of state observers - separation principle - servo design - state feedback with integral control.

UNIT-II PHASE PLANE ANALYSIS 9

Features of linear and non-linear systems - Common physical non-linearities – Methods of linearization - Concept of phase portraits – Singular points – Limit cycles – Construction of phase portraits – Phase plane analysis of linear and non-linear systems – Isocline method.

UNIT-III DESCRIBING FUNCTION ANALYSIS 9

Basic concepts, derivation of describing functions for common non-linearities – Describing function analysis of non-linear systems – limit cycles – Stability of oscillations.

UNIT- IV OPTIMAL CONTROL 9

Introduction - Time varying optimal control – LQR steady state optimal control – Solution of Ricatti's equation – Application examples.

UNIT-V OPTIMAL ESTIMATION 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

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

Course Name : MODERN CONTROL SYSTEM											**Course Code : 20EEV15**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C306V5.1	Develop state model for pole placement.										I	K3	1,2,3	1,2
C306V5.2	Design state observers.										II	K3	1,2,3	1,2
C306V5.3	Construct phase plane trajectories using isocline method for the given system.										III	K3	1,2,3	1,2
C306V5.4	Derive describing function for various non linear systems.										IV	K3	1,2,3	1,2
C306V5.5	Explain the optimal control with examples.										V	K3	1,2,3	1,2
C306V5.6	Explain optimal estimation for discrete system and design Kalman filters.										V	K3	1,2,3	1,2
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C306V5.1	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C306V5.2	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C306V5.3	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C306V5.4	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C306V5.5	3	3	1	-	-	-	-	-	-	-	-	-	2	2
C306V5.6	3	2	1	-	-	-	-	-	-	-	-	-	2	2

20EEV16	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

OBJECTIVES

- To provide knowledge about optimization techniques and approaches.
- To formulate a real time problem as a mathematical programming model.
- To gain mathematical, computational and communication skills for solving problems.
- To gain knowledge to solve networking and inventory problems.
- To gain knowledge on solving different waiting line models

PREREQUISITE: NIL

UNIT - I LINEAR PROGRAMMING 9

Introduction to Operations Research, Linear programming (LP) – assumptions, properties of LP solutions, Formulations of linear programming problem – Graphical method. Solutions to LPP – simplex, Big M method.

UNIT – II TRANSPORTATION AND ASSIGNMENT MODELS 9

Transportation Problem - Mathematical Model, Types – Balanced and Unbalanced, Solution to Transportation Problem - Finding the initial basic solution, Optimizing the basic feasible solution applying U–V Method (Modi method)

Assignment problem –Hungarian method, Travelling salesman problem - Branch and Bound technique.

UNIT - III NETWORK MODELS 9

Network problem: shortest path – Systematic method, Dijkstra's algorithm, Floyd's algorithm, Minimal spanning tree – PRIM and Kruskal's algorithm, Maximum flow models – linear programming models, maximal flow problem algorithm

Project network representation, Critical Path Method computations, construction of time schedule, linear programming formulation of CPM, PERT networks.

UNIT – IV INVENTORY MODELS 9

Inventory models, Quantity Discount, Purchase Inventory Model - Q System, P System, Multiple-item Model - Shortage Limitation, Inventory Carrying Cost Constraint, EOQ Model - Multi-item Joint Replenishment with and without Shortages, Space Constraint.

UNIT - V QUEUEING MODELS 9

Queuing models - Queuing systems and structures – Notation parameter – Single server and multi server models – Poisson input – Exponential service – Constant rate service – Infinite population.

TOTAL : 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

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

Course Name : OPERATIONS RESEARCH											**Course Code : 20EEV16**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C306V6.1	Solve Linear Programming Problems by appropriate technique.										I	K3	1,2,3, 8,10	1,2,3
C306V6.2	Determine the performance characteristics such as time and cost in solving shortest route, transportation problems with an appropriate model.										II	K3	1,2,3, 9,10	1,2,3
C306V6.3	Solve the given assignment problem with an appropriate method.										II	K3	1,2,3, 8,10	1,2,3
C306V6.4	Determine the optimal solution for a project scheduling problem.										III	K3	1,2,3	1,2,3
C306V6.5	Determine the order quantity of goods under different constraints.										IV	K3	1,2,3, 8	1,2,3
C306V6.6	Determine the solutions to single and multi channel queuing problems.										V	K3	1,2,3, 8,9,10	1,2,3
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C306V6.1	3	2	1	-	-	-	-	2	-	2	-	2	3	2
C306V6.2	3	2	1	-	-	-	-	-	2	2	-	2	3	2
C306V6.3	3	2	1	-	-	-	-	2	-	2	-	2	3	2
C306V6.4	3	2	1	-	-	-	-	-	-	-	-	2	3	2
C306V6.5	3	2	1	-	-	-	-	2	-	-	-	2	3	2
C306V6.6	3	2	1	-	-	-	-	1	2	2	-	2	3	2

PROFESSIONAL ELECTIVE – II

20EEV21	SMART GRID	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart knowledge about the following topics:

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

PRE-REQUISITE:
Course Code: 20EE402
Course Name: Transmission and Distribution

UNIT - I INTRODUCTION TO SMART GRID 9

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

UNIT - II SMART GRID TECHNOLOGIES (TRANSMISSION) 9

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

UNIT - III SMART GRID TECHNOLOGIES (DISTRIBUTION) 9

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

UNIT - IV SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

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

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

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

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Stuart Borlase “Smart Grid: Infrastructure, Technology and Solutions”, CRC Press 2012.
2. Janaka Ekanayake, NickJ enkins, Kithsiri Liyanage, JianzhongWu, AkihikoYokoyama, “Smart Grid: Technology and Applications”, Wiley 2012.

REFERENCES:

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

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

Course Name : SMART GRID												**Course Code : 20EEV21**			
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSOs**
C313V1.1	Discuss the functions, opportunities, challenges and benefits of Smart Grid											I	K2	1,2	1
C313V1.2	Describe the Smart energy resources and Transmission systems											II	K2	1,2	1
C313V1.3	Explain the different Smart Grid distribution technologies											III	K2	1,2	1
C313V1.4	Discuss the function of different smart meters and advanced metering infrastructure.											IV	K2	1,2	1
C313V1.5	Summarize the power quality management in Smart Grids											V	K2	1,2	1
C313V1.6	Describe the basic service on LAN, WAN and Cloud Computing for Smart Grid applications.											V	K2	1,2	1
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**		**PSO1**	**PSO2**
C313V1.1	2	1	-	-	-	-	-	-	-	-	-	-		1	-
C313V1.2	2	1	-	-	-	-	-	-	-	-	-	-		1	-
C313V1.3	2	1	-	-	-	-	-	-	-	-	-	-		1	-
C313V1.4	2	1	-	-	-	-	-	-	-	-	-	-		1	-
C313V1.5	2	1	-	-	-	-	-	-	-	-	-	-		1	-
C313V1.6	2	1	-	-	-	-	-	-	-	-	-	-		1	-

20EEV22	SPECIAL ELECTRICAL MACHINES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the characteristics and modes of excitation of stepper motor.
- To understand the power controllers and the modes of operation of switched reluctance motor.
- To understand the construction and principle of operation of permanent magnet brushless dc motor.
- To understand the power controller circuit for permanent magnet synchronous motor.
- To understand the construction and principle of operation of synchronous reluctance motor.

PRE-REQUISITE:

Course Code: 20EE304, 20EE401
Course Name: Electrical Machines-I, Electrical Machines-II

UNIT - I STEPPER MOTOR 10

Construction and Principle of operation - Variable reluctance stepper motor - Permanent magnet stepper motor - Hybrid stepper motor - Static and dynamic characteristics - Driver circuit - Applications and advantages.

UNIT - II SWITCHED RELUCTANCE MOTORS 9

Constructional features - Principle of operation - Torque equation - Power controllers - Control circuits for SRM - Torque speed Characteristics - Microprocessor based controller.

UNIT - III PERMANENT MAGNET BRUSHLESS DC MOTOR 10

Permanent Magnet materials - Characteristics - construction and principle of operation - Types - Difference between mechanical and electronic commutators - EMF and torque equations - torque speed characteristics - Hall sensors - optical position sensors - Microprocessor Based controller.

UNIT - IV PERMANENT MAGNET SYNCHRONOUS MOTOR 9

Principle of operation - EMF and Torque equations - self-control - vector control - Torque speed Characteristics - Microprocessor based control – Applications.

UNIT - V SYNCHRONOUS RELUCTANCE MOTORS 7

Construction and operating principle - Axial and radial air gap motors - Phasor diagram - Voltage and torque equation - Characteristics and its Applications.

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

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

Course Name : SPECIAL ELECTRICAL MACHINES											**Course Code : 20EEV22**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C313V2.1	Explain the construction and Principle of operation of stepper motor										I	K2	1,2	1
C313V2.2	Discuss the construction and Principle of operation of SRM										II	K2	1,2	1
C313V2.3	Describe the construction and Principle of operation of Permanent Magnet Brushless DC Motor										III	K2	1,2	1
C313V2.4	Explain the operation Microprocessor Based controller for PMBLDC										III	K2	1,2	1
C313V2.5	Discuss the Principle of operation of Permanent Magnet Synchronous Motor										IV	K2	1,2	1
C313V2.6	Describe the construction and Principle of operation of Synchronous Reluctance Motors										V	K2	1,2	1
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C313V2.1	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C313V2.2	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C313V2.3	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C313V2.4	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C313V2.5	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C313V2.6	2	1	-	-	-	-	-	-	-	-	-	-	2	-

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

OBJECTIVES: To impart knowledge about the following topics:

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

PRE-REQUISITE:
Course Code: 20EE401
Course Name: Electrical Machines – II

UNIT - I ELECTRIC VEHICLES AND VEHICLE MECHANICS 9

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

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

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

UNIT - III CONTROL OF DC AND AC DRIVES 9

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

UNIT - IV BATTERY ENERGYSTORAGE SYSTEM 9

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

UNIT - V ALTERNATIVE ENERGYSTORAGE SYSTEMS 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

OUTCOMES:

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

Course Name : ELECTRIC VEHICLES AND POWER MANAGEMENT											**Course Code : 20EEV23**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C313V3.1	Demonstrate the operation of Electric vehicles and various energy storage technologies for electrical vehicles										I	K2	1,2	1
C313V3.2	Explain the Architecture of EV’s and Power Train Components										II	K2	1,2	1
C313V3.3	Discuss the Control of DC drives										III	K2	1,2	1
C313V3.4	Describe the Control of AC drives										III	K2	1,2	1
C313V3.5	Explain about various types of Battery energy storage system										IV	K2	1,2	1
C313V3.6	Generalize the Alternative energy storage system										V	K2	1,2	1
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C313V3.1	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C313V3.2	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C313V3.3	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C313V3.4	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C313V3.5	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C313V3.6	2	1	-	-	-	-	-	-	-	-	-	-	1	-

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

OBJECTIVES:

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

PRE-REQUISITE: NIL

UNIT - I BASIC C PROGRAMMING **9**

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

UNIT - II EMBEDDED C **9**

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

UNIT - III C PROGRAMMING TOOL-CHAIN IN LINUX **9**

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

UNIT - IV PYTHON PROGRAMMING **9**

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

UNIT - V MODULES, PACKAGES AND LIBRARIES IN PYTHON **9**

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

1. Paul Deitel and Harvey Deitel, "C How to Program", 8th Edition, Pearson Education Limited, 2016.
2. William von Hagen, "The Definitive Guide to GCC", 2nd Edition, Apress Inc., 2006.

3. Noel Kalicharan, "Learn to Program with C", Apress Inc., 2015.
4. Steve Oualline, "Practical C programming", O'Reilly Media, 1997.
5. Fabrizio Romano, “Learn Python Programming”, Second Edition, Packt Publishing, 2018.
6. John Paul Mueller, "Beginning Programming with Python for Dummies", 2nd Edition, John Wiley& Sons Inc., 2018.
7. Mark Lutz, "Programming Python", 4th Edition, O’Reilly Media Inc., 2010

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

Course Name : EMBEDDED C-PROGRAMMING													**Course Code : 20EEV24**	
CO	**Course Outcomes**												**Unit**	**K –CO**	**POs**	**PSOs**
C313V4.1	Demonstrate C programming and its salient features for embedded systems												I	K2	1,2	1
C313V4.2	Deliver insight into various programming languages/software compatible to embedded processdevelopment with improved design & programming skills.												II	K3	1,2,3	1
C313V4.3	Develop knowledge on C programming in Linux environment.												III	K2	1,2	1
C313V4.4	Possess ability to write python programming for Embedded applications.												IV	K2	1,2	1
C313V4.5	Develop the Modules, Packages and Libraries for Python.												V	K2	1,2	1
C313V4.6	Have improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded programming skills.												V	K2	1,2	1
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**		
C313V4.1	2	1	-	-	-	-	-	-	-	-	-	-	1	-		
C313V4.2	3	2	1	-	-	-	-	-	-	-	-	-	2	-		
C313V4.3	2	1	-	-	-	-	-	-	-	-	-	-	1	-		
C313V4.4	2	1	-	-	-	-	-	-	-	-	-	-	1	-		
C313V4.5	2	1	-	-		-	-	-	-	-	-	-	1	-		
C313V4.6	2	1	-	-	-	-	-	-	-	-	-	-	1	-		

20EEV25	SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart knowledge about the following topics:

- The concept of system identification and adaptive control
- Black-box approach based system identification
- Batch and recursive identification
- Computer Controlled Systems
- Design concept for adaptive control schemes

PRE-REQUISITE:

Course Code: 20EE504
Course Name: Control Systems

UNIT - I NON-PARAMETRIC METHODS 9

Non-parametric methods - Transient analysis - frequency analysis - Correlation analysis - Spectral analysis - Input signal design for identification.

UNIT - II PARAMETRIC METHODS 9

Least squares estimation – Analysis of the least squares estimate - Best linear unbiased estimate – Model parameterizations - Prediction error methods.

UNIT - III RECURSIVE IDENTIFICATION METHODS 9

The recursive least square method - Model validation –Model structure determination - Introduction to closed loop system identification.

UNIT - IV ADAPTIVE CONTROL SCHEMES 9

Introduction – Auto-tuning of PID controller using relay feedback approach – Types of adaptive control, Gain scheduling, Model reference adaptive control, Self–tuning controller – Design of gain scheduled adaptive controller – Applications of gain scheduling.

UNIT - V MODEL-REFERENCE ADAPTIVE SYSTEM (MRAS) and SELF-TUNING REGULATOR (STR) 9

STR – Pole placement design – Indirect STR and direct STR – MRAC - MIT rule – Lyapunov theory – Relationship between MRAC and STR.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. T. Soderstrom and PetreStoica, System Identification, Prentice Hall International (UK) Ltd. 1989
2. Karl J. Astrom and Bjorn Witten mark, Adaptive Control, Pearson Education, Second edition, Fifth impression, 2009.

REFERENCES:

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

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

Course Name : SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL											**Course Code : 20EEV25**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C313V5.1	Explain the various system identification techniques and features of adaptive control.										I	K2	1,2	-
C313V5.2	Explain the concept of system identification and adaptive control										II	K2	1,2	-
C313V5.3	Explain about Black-box approach based system identification										III	K2	1,2	-
C313V5.4	Discuss the batch and recursive identification.										IV	K2	1,2	-
C313V5.5	Explain about the computer controlled systems.										V	K2	1,2	-
C313V5.6	Explain the concept for adaptive control schemes										V	K2	1,2	-
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C313V5.1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C313V5.2	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C313V5.3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C313V5.4	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C313V5.5	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C313V5.6	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C313V5	2	1	-	-	-	-	-	-	-	-	-	-	-	-

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

OBJECTIVES:

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

PRE-REQUISITE: NIL

UNIT - I FUNDAMENTALS OF A COMPUTER SYSTEM 9

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

UNIT - II ARITHMETIC FOR COMPUTERS 9

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

UNIT - III PROCESSOR AND CONTROL UNIT 9

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

UNIT - IV PARALLELISIM 9

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

UNIT - V MEMORY & I/O SYSTEMS 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

OUTCOMES:

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

Course Name : COMPUTER ORGANIZATION AND ARCHITECTURE											**Course Code : 20EEV26**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C313V6.1	Explain the computer organization components, instructions and addressing modes.										I	K2	1,2	1
C313V6.2	Compute the arithmetic operations such as Addition, Subtraction, Multiplication and Division.										II	K3	1-3,8,9	1
C313V6.3	Discuss the basics of MIPS implementation and pipelining.										III	K2	1,2,8-10,12	1
C313V6.4	Illustrate the basic concepts of parallelism, multi-core processor, GPU & Clusters.										IV	K2	1,2,8,9,12	1
C313V6.5	Describe the memory technologies & I/O systems.										V	K2	1,2,8-10,12	1
C313V6.6	Utilize Raspberry-pi for demonstrating memory systems.										V	K3	1-3,5,8,9,12	1,2
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C313V6.1	2	1	-	-	-	-	-		-	-	-	-	2	-
C313V6.2	3	2	1	-	-	-	-	1	1	-	-	-	3	-
C313V6.3	2	1	-	-	-	-	-	1	1	1	-	1	2	-
C313V6.4	2	1	-	-	-	-	-	1	1	-	-	1	2	-
C313V6.5	2	1	-	-	-	-	-	1	1	1	-	1	2	-
C313V6.6	3	2	1	-	1	-	-	1	1	-	-	1	2	1

PROFESSIONAL ELECTIVE – III

20EEV31	FLEXIBLE AC TRANSMISSION SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart knowledge about the following topics:

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

PRE-REQUISITE:

Course Code: 20EE402

Course Name: Transmission and Distribution

UNIT - I INTRODUCTION 9

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

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

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

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

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

UNIT - IV VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS 9

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

UNIT - V ADVANCED FACTS CONTROLLERS 12

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

OUTCOMES:

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

Course Name : FLEXIBLE AC TRANSMISSION SYSTEMS											**Course Code : 20EEV31**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C314V1.1	Develop analytical model of FACTS controller for power system application.										I	K2	1,2	1
C314V1.2	Explain the concepts about load compensation techniques.										I	K2	1,2	1
C314V1.3	Explain about facts devices.										II	K2	1,2	1
C314V1.4	Discuss the start-of-art of the power system										III	K2	1,2	1
C314V1.5	Describe the performance of steady state and transients of facts controllers.										IV	K2	1,2	1
C314V1.6	Discuss about advanced FACTS controllers.										V	K2	1,2	1
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C314V1.1	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C314V1.2	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C314V1.3	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C314V1.4	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C314V1.5	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C314V1.6	2	1	-	-	-	-	-	-	-	-	-	-	1	-

20EEV32	SOLID STATE DRIVES	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

PRE-REQUISITE:

Course Code: 20EE302, 20EE304, 20EE401, 20EE502
Course Name: Electron Devices and Circuits, Electrical Machines-I, Electrical Machines-II, Power Electronics.

UNIT - I DRIVE CHARACTERISTICS 9

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

UNIT - II DC MOTOR DRIVES 9

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

UNIT - III INDUCTION MOTOR DRIVES 9

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

UNIT - IV SYNCHRONOUS MOTOR DRIVES 9

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

UNIT - V DESIGN OF CONTROLLERS FOR DC DRIVES 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

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

Course Name : SOLID STATE DRIVES												**Course Code : 20EEV32**			
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSOs**
C314V2.1	Explain the basics and importance of electric drives.											I	K2	1,2	1
C314V2.2	Explain the operation of the various converter fed separately excited dc motor drives.											II	K2	1,2	1
C314V2.3	Describe the operation of the various Chopper fed separately excited dc motor drives.											II	K2	1,2	1
C314V2.4	Explain the various solid state speed control methods of induction motor drives.											III	K2	1,2	1
C314V2.5	Discuss the various speed control methods of synchronous motor drives and applications.											IV	K2	1,2	1
C314V2.6	Apply the knowledge of Electrical Engineering fundamentals to develop current and speed controllers for a closed loop solid state dc motor drive.											V	K3	1,2,3	1
C314V2.7	Apply the ethical principles, function effectively as an individual and communicate effectively on the assigned activities. (Activity Based to map higher order POs)											-	-	1,2,3,4,8, 9,10	1,2
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**		**PSO1**	**PSO2**
C314V2.1	2	1	-	-	-	-	-	-	-	-	-	-		1	-
C314V2.2	2	1	-	-	-	-	-	-	-	-	-	-		1	-
C314V2.3	2	1	-	-	-	-	-	-	-	-	-	-		1	-
C314V2.4	2	1	-	-	-	-	-	-	-	-	-	-		1	-
C314V2.5	2	1	-	-		-	-	-	-	-	-	-		1	-
C314V2.6	3	2	1	-	-	-	-	-	**-**	-	-	-		2	-
C314V2.7	3	3	2	1	-	-	-	**2#**	**2#**	**2#**		-		1	**2**

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

OBJECTIVES:

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

PRE-REQUISITE: NIL

UNIT - I INTERNAL COMBUSTION ENGINES 6

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

UNIT - II ELECTRIC VEHICLES AND VEHICLE MECHANICS 6

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

UNIT - III BATTERY MODELING, TYPES AND CHARGING 6

Batteries in Electric and Hybrid Vehicles - Battery Basics - Battery Parameters. Types - Lead Acid Battery - Nickel-Cadmium Battery - Nickel-Metal-Hydride (NiMH) Battery - Li-Ion Battery - Li-Polymer Battery, Zinc-Air Battery, Sodium-Sulphur Battery, Sodium-Metal Chloride, Research and Development for Advanced Batteries. Battery Modelling, Electric Circuit Models. Battery Pack Management, Battery Charging.

UNIT - IV CONTROL PRELIMINARIES 6

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

UNIT - V CONTROLOFACMACHINES 6

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

TOTAL: 30 PERIODS

LABCOMPONENT: 30 PERIODS

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

TOTAL: 60 PERIODS

REFERENCES:

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

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

Course Name : ELECTRIC VEHICLE DESIGN, MECHANICS AND CONTROL											Course Code : 20EEV33			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C314V3.1	Describe the concepts related with EV, HEV and to compare the same with internal combustion engine vehicles.										I	K2	1,2	1
C314V3.2	Discuss the fundamentals of vehicle mechanics										II	K3	1,2	1
C314V3.3	Explain the concepts related with batteries and parameters of battery										III	K2	1,2	1
C314V3.4	Demonstrate the battery and to study the research and development for batteries										III	K2	1,2	1
C314V3.5	Determine the gain margin & phase margin for various types of transfer functions of boost converter										IV	K2	1,2	1
C314V3.6	Demonstrate the Control of AC Machines										V	K2	1,2	1
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C314V3.1	2	1	-	-	2	-	-	-	1	-	-	-	1	-
C314V3.2	2	1	-	-	2	-	-	-	1	-	-	-	1	-
C314V3.3	2	1	-	-	2	-	-	-	1	-	-	-	1	-
C314V3.4	2	1	-	-	2	-	-	-	1	-	-	-	1	-
C314V3.5	2	1	-	-	2	-	-	-	1	-	-	-	1	-
C314V3.6	2	1	-	-	2	-	-	-	1	-	-	-	1	-

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

OBJECTIVES:

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

PRE-REQUISITE: NIL

UNIT – I INTRODUCTION TO EMBEDDED SYSTEMS 9

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

UNIT – II EMBEDDED NETWORKING 9

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

UNIT - III INTERRUPTS SERVICE MECHANISM AND DEVICE DRIVERS 9

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

UNIT - IV RTOS BASED EMBEDDED SYSTEM 9

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

UNIT - V EMBEDDED SYSTEM APPLICATION WITH DEVELOPMENT 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

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

Course Name : EMBEDDED SYSTEM DESIGN											**Course Code : 20EEV34**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C314V4.1	Explain the basic build process of embedded systems										I	K2	1,2	1
C314V4.2	Describe the different types of I/O device ports, buses and different interfaces for data transfer in embedded networking										II	K2	1,2	1
C314V4.3	Explain the interrupt service mechanism and device drivers.										III	K2	1,2	1
C314V4.4	Explain the basic concept of Real Time Operating Systems										IV	K2	1,2	1
C314V4.5	Apply the knowledge of programming concepts of Embedded Systems for various applications										V	K3	1,2,3	1
C314V4.6	Explain the different phases and modeling of the EDLC.										V	K2	1,2	1
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C314V4.1	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C314V4.2	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C314V4.3	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C314V4.4	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C314V4.5	3	2	1	-	-	-	-	-	-	-	-	-	2	-
C314V4.6	2	1	-	-	-	-	-	-	-	-	-	-	2	-
C314V4	2	1	-	-	-	-	-	-	-	-	-	-	2	-

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

OBJECTIVES:

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

PRE-REQUISITE:

Course Code: 20EE504
Course Name: Control Systems

UNIT – I INTRODUCTION TO OPTIMAL CONTROL 9

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

UNIT – II CALCULUS OF VARIATIONS 9

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

UNIT - III LINEAR QUADRATIC OPTIMAL CONTROL SYSTEM 9

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

UNIT - IV DISCRETE TIME OPTIMAL CONTROL SYSTEM 9

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

UNIT - V PONTRYAGIN MINIMUM PRINCIPLE 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

1. D. Subbaram Naidu, Optimal Control Systems, CRC Press, New York, 2003, 1st Edition.
2. Yan Wang, Cheng-Lin Liu, Zhi-Cheng Ji, Quantitative Analysis and Optimal Control of Energy Efficiency in Discrete Manufacturing System, Springer, 2020, 1st Edition.
3. Lewis F.L. Draguna Vrabia, Syrmos V.L, Optimal control, John Wiley & sons, 2012.

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

Course Name : OPTIMAL CONTROL													**Course Code : 20EEV35**	
CO	**Course Outcomes**												**Unit**	**K –CO**	**POs**	**PSOs**
C314V5.1	Formulate the optimization problem based on the requirements and evaluate theperformance of optimal controller												I	K2	1,2	1
C314V5.2	Apply the variational approach for optimal control systems with conditions												II	K2	1,2	1
C314V5.3	Differentiate finite time LQR and infinite time LQR and design linear quadratic trackingsystem												III	K2	1,2	1
C314V5.4	Analyze discrete time optimal control systems used in different applications												IV	K2	1,2	1
C314V5.5	Design constrained optimal control system and time optimal control system												V	K3	1,2,3	1
C314V5.6	Design optimal control system with constraints.												V	K2	1,2	1
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**		
C314V5.1	2	1	-	-	-	-	-	-	-	-	-	-	1	-		
C314V5.2	2	1	-	-	-	-	-	-	-	-	-	-	2	-		
C314V5.3	2	1	-	-	-	-	-	-	-	-	-	-	2	-		
C314V5.4	2	1	-	-	-	-	-	-	-	-	-	-	1	-		
C314V5.5	3	2	1	-	-	-	-	-	-	-	-	-	2	-		
C314V5.6	2	1	-	-	-	-	-	-	-	-	-	-	2	-		

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

OBJECTIVES:

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

PRE-REQUISITE: NIL

UNIT - I INTRODUCTION TO BLOCKCHAIN 10

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

UNIT - II BLOCKCHAIN ARCHITECTURE, DESIGN AND CONSENSUS 8

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

UNIT - III PERMISSIONED AND PUBLIC BLOCKCHAINS 9

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

UNIT - IV BLOCKCHAIN CRYPTOGRAPHY 9

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

UNIT - V RECENT TRENDS AND RESEARCH ISSUES IN BLOCKCHAIN 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

OUTCOMES:

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

Course Name : BLOCK CHAIN TECHNOLOGY													Course Code : 20EEV36	
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C314V6.1	Discuss the basic of block chain in terms of protocols and security and privacy										1	K2	1,2,8,9	-
C314V6.2	Explain the crypto primitives of block chain architecture										2	K2	1,2,8,9	-
C314V6.3	Illustrate the appropriate Consensus design for application protocol										2	K2	1,2,8,9	-
C314V6.4	Apply Hyper ledger Fabric to implement the Block chain										3	K3	1,2,3,8 ,9,12	-
C314V6.5	Apply various cryptographic techniques in Block chain cryptography, privacy and security										4	K3	1,2,3,8 ,9,12	-
C314V6.6	Discuss the research issues of Block chain										5	K2	1,2,8,9	-
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C314V6.1	2	1	-	-	-	-	-	1	**1**	-	-	-	-	-
C314V6.2	2	1	-	-	-	-	-	1	1	-	-	-	-	-
C314V6.3	2	1	-	-	-	-	-	1	1	-	-	-	-	-
C314V6.4	3	2	1	-	-	-	-	1	1	-	-	1	-	-
C314V6.5	3	2	1	-	1	1	-	1	1	-	-	1	-	-
C314V6.6	2	1	-	-	-	-	-	1	1	-	-	-	-	-

PROFESSIONAL ELECTIVE – IV

		L	T	P	C
20EEV41	**ENERGY AUDITING AND MANAGEMENT**	**3**	**0**	**0**	**3**

OBJECTIVES: To impart knowledge on the following Topics

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

PRE-REQUISITE:

Course Code: 20EE304, 20EE401, 20EE402
Course Name: Electrical Machines-I, Electrical Machines-II, Transmission and Distribution

UNIT - I INTRODUCTION 9

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

UNIT - II ENERGY MANAGEMENT FOR MOTORS AND COGENERATION 9

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

UNIT - III LIGHTING SYSTEMS 9

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

UNIT - IV METERING FOR ENERGY MANAGEMENT 9

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

UNIT - V ECONOMIC ANALYSIS AND MODELS 9

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

TOTAL: 45PERIODS

TEXT BOOKS:

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

REFERENCES:

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

OUTCOMES:

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

Course Name : ENERGY AUDITING AND MANAGEMENT											**Course Code : 20EEV41**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C315V1.1	Explain the importance of energy management and auditing.										I	K2	1,2,6,7	1
C315V1.2	Describe energy management on different types of electrical equipment.										II	K3	1,2,6,7	1
C315V1.3	Explain the Forms and feasibility of cogeneration										II	K3	1,2,6,7	1
C315V1.4	Discuss the energy management on different types of lighting system and light sources.										III	K3	1,2,6,7	1
C315V1.5	Describe the different types of metering methods of energy management and auditing.										IV	K4	1,2,6,7,12	1
C315V1.6	Explain the economic models for energy and load management.										V	K2	1,2,6,7	1
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C315V1.1	2	1	-	-	-	1	1	-	-	-	-	-	1	-
C315V1.2	2	1	-	-	-	1	1	-	-	-	-	-	1	-
C315V1.3	2	1	-	-	-	1	1	-	-	-	-	-	1	-
C315V1.4	2	1	-	-	-	1	1	-	-	-	-	-	1	-
C315V1.5	2	1	-	-	-	1	1	-	-	-	-	1	1	-
C315V1.6	2	1	-	-	-	1	1	-	-	-	-	-	1	-

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

OBJECTIVES:

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

PRE-REQUISITE:

Course Code: 20EE502
Course Name: Power Electronics

UNIT - I CONTROL OF DC DRIVES 9

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

UNIT - II CONTROL OF INDUCTION MOTOR DRIVE 9

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

UNIT - III CONTROL OF SYNCHRONOUS MOTOR DRIVES 9

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

UNIT - IV CONTROL OF SRM AND BLDC MOTOR DRIVES 9

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

UNIT - V DIGITAL CONTROL OF DC DRIVE 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Gopal K.Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, Second Edition, 2015.

2. Krishnan R., " Electric Motor & Drives: Modelling, Analysis and Control", Pearson Education, 2015

REFERENCES:

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

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

Course Name : CONTROL OF ELECTRICAL DRIVES											Course Code : 20EEV42			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C315V2.1	Explain the various control strategies and controllers for DC Motor Drive systems.										I	K2	1,2	1
C315V2.2	Discuss the various control strategies and controllers for Induction Motor Drive systems and develop the closed loop operation of V/f control of Induction motor drive systems.										II	K3	1,2,3	1
C315V2.3	Describe the various control strategies and controllers for Synchronous Motor Drive systems.										III	K2	1,2	1
C315V2.4	Explain the various control strategies and controllers for SRM Motor Drive systems.										IV	K2	1,2	1
C315V2.5	Discuss the various control strategies and controllers for BLDC Motor Drive systems.										IV	K2	1,2	1
C315V2.6	Explain the various Digital control for DC Motor Drive systems.										V	K2	1,2	1
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C315V2.1	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C315V2.2	3	2	1	-	-	-	-	-	-	-	-	-	2	-
C315V2.3	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C315V2.4	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C315V2.5	2	1	-	-		-	-	-	-	-	-	-	1	-
C315V2.6	2	1	-	-	-	-	-	-	-	-	-	-	1	-

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

OBJECTIVES:

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

PRE-REQUISITE: NIL

UNIT - I ENERGY STORAGE SYSTEM 9

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

UNIT - II BATTERY CHARACTERISTICS & PARAMETERS 9

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

UNIT - III BATTERY MODELLING 9

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

UNIT - IV BATTERY PACK AND BATTERY MANAGEMENT SYSTEM 9

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

UNIT - V BATTERY TESTING, DISPOSAL & RECYCLING 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

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

Course Name : DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM											**Course Code : 20EEV43**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C315V3.1	Discuss about the different types of energy storage system.										I	K2	1,2	1
C315V3.2	Describe about the battery characteristic & parameters.										II	K2	1,2	1
C315V3.3	Explain the different types of batteries.										III	K2	1,2	1
C315V3.4	Explain the concepts of battery pack design.										IV	K2	1,2	1
C315V3.5	Explain the concepts of battery management system										IV	K2	1,2	1
C315V3.6	Explain about the battery testing, disposal and recycling.										V	K2	1,2	1
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C315V3.1	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C315V3.2	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C315V3.3	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C315V3.4	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C315V3.5	2	1	-	-		-	-	-	-	-	-	-	1	-
C315V3.6	3	2	1	-	-	-	-	-	-	-	-	-	2	-

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

OBJECTIVES:

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

PRE-REQUISITE:

Course Code: 20EE304, 20EE401, 20EE505
Course Name: Electrical Machines-I, Electrical Machines-II, Microprocessors, Microcontrollers and Applications

UNIT - I INTRODUCTION TO ELECTRIC DRIVES **6**

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

UNIT - II EMBEDDED SYSTEM FOR MOTOR CONTROL **6**

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

UNIT - III INDUCTION MOTOR CONTROL **6**

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

UNIT - IV BLDC MOTOR CONTROL **6**

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

UNIT - V SRM MOTOR CONTROL **6**

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

TOTAL: 30 PERIODS

LABCOMPONENT: 30 PERIODS

1. Laboratory exercise: Use any System level simulator/MATLAB/open source platform to give hands-on training on simulation study on Electric drives and control.
   a. Simulation of four quadrant operation and speed control of DC motor
   b. Simulation of 3-phase inverter.
   c. Simulation of Speed control of Induction motor using any suitable software package.
   d. Simulation of Speed control of BLDC motor using any suitable software package.
   e. Simulation of Speed control of SRM using any suitable software package
2. Seminar: IoT-based Control and Monitoring for DC Motor/any Electric drives.
3. Mini project.: Any Suitable Embedded processor-based speed control of Motors (DC/IM/BLDC/PMSM/SRM)

TOTAL: 60 PERIODS

TEXTBOOKS:

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

REFERENCES:

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

List of Open Source Software/Learning website:

1) https://archive.nptel.ac.in/courses/108/104/108104140/
2) https://www.embedded.com/mcus-or-dsps-which-is-in-motor-control/
3) https://www.e3sconferences.org/articles/e3sconf/pdf/2019/13/e3sconf_SeFet2019_01004.pdf
4) https://www.electronics-tutorials.ws/blog/pulse-width-modulation.html
5) http://kaliasgoldmedal.yolasite.com/resources/SEM/SRM.pdf

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

Course Name : EMBEDDED CONTROL FOR ELECTRIC DRIVES													Course Code : 20EEV44	
CO	**Course Outcomes**												**Unit**	**K –CO**	**POs**	**PSOs**
C315V4.1	Interpret the significance of embedded control of electrical drive												I	K2	1,2	1
C315V4.2	Developing knowledge of Machine learning and optimization techniques for motor control.												I	K2	1,2	1
C315V4.3	Deliver in sight in to various control strategies for electrical drives.												II	K2	1,2	1
C315V4.4	Explain the speed control operation of Embedded processor based induction motor.												III	K2	1,2	1
C315V4.5	Discuss the speed control operation of Embedded processor based BDLC motor.												IV	K2	1,2	1
C315V4.6	Describe the speed control operation of Embedded processor based SRM motor.												V	K3	1,2,3	1
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**		
C315V4.1	1	1	2	2	1	-	-	-	-	-	-	-	2	1		
C315V4.2	2	1	3	2	1	-	-	-	-	-	-	-	2	1		
C315V4.3	3	2	3	3	3	-	-	-	-	-	-	-	1	3		
C315V4.4	3	2	3	3	3	-	-	-	-	-	-	-	3	3		
C315V4.5	3	2	1	2	1	-	-	-	1	-	-	-	2	2		
C315V4.6	3	2	2	2	2	-	-	-	1	-	-	-	2	2		

20EEV45	PROCESS MODELING AND SIMULATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the process control loop and obtain the mathematical model of differentprocesses.
- To educate on the conventional PID controller and it associated features and design thePID controller using different tuning techniques.
- To elaborate different types of control schemes such as cascade control, feed forwardcontrol etc.
- To educate on multivariable systems and multi-loop control.
- To educate on various industrial processes.

PRE-REQUISITE: NIL

UNIT - I PROCESS DYNAMICS 9

Need for process control – The process control loop – Continuous and batch processes – P & I diagram - Self-regulation - Interacting and non-interacting systems - Mathematical models of level, flow and thermal processes – Linearization of nonlinear systems.

UNIT - II PID CONTROLLER AND TUNING 9

Characteristic of ON-OFF, P, P+I, P+D and P+I+D control modes – Digital PID algorithm – Auto/manual transfer – Reset windup – Practical forms of PID controller – Evaluation criteria – IAE, ISE, ITAE and ¼ decay ratio – Tuning – Process reaction curve method and Z-N and Cohen-Coon techniques – Continuous cycling and damped oscillation methods – Auto-tuning.

UNIT - III ENHANCEMENT OF SINGLE-LOOP CONTROL & MODEL BASED CONTROL SCHEMES 9

Cascade control – Split-range control – Feed-forward control – Ratio control – Inferential control – override control – Smith predictor control scheme – Internal model control (IMC) – IMC PID controller – Dynamic matrix control – Generalized predictive control.

UNIT - IV MULTIVARIABLE SYSTEMS & MULTI-LOOP CONTROL 9

Multivariable systems – Transfer matrix representation – Poles and zeros of MIMO system - Introduction to multi-loop control – Process Interaction – Pairing of inputs and outputs –The relative gain array (RGA) – Properties and applications of RGA – Multi-loop PID controller – Decoupling control – Multivariable PID controller.

UNIT - V CASE-STUDIES 9

Model predictive control – Control schemes for distillation column, CSTR, four-tank system and pH.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Stephanopoulos G, “Chemical Process Control”, Pearson, 2015.
2. Bequette WB, “Process Control: Modeling, Design and Simulation”, Prentice Hall India, 2003.

REFERENCES:

1. Seborg DE, Mellichamp DA, & Edgar TF, “Process Dynamics and Control”, Wiley, 2013.
2. Chidambaram M, “Computer Control of Processes”, Narosa, 2006.
3. Luyben WL, “Process Modeling, Simulation and Control for Chemical Engineers”, 2013.
4. Johnson CD, “Process Control Instrumentation Technology”, Pearson, 2015.
5. Coughanowr DR & Le Blanc SE, “Process Systems Analysis and Control”, McGraw Hill,2013.

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

Course Name : PROCESS MODELING AND SIMULATION												**Course Code : 20EEV45**			
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSOs**
C315V5.1	Ability to apply knowledge of mathematics, science, and engineering to the build andanalyze models for flow, level, and thermal processes.											I	K2	1,2	1
C315V5.2	Ability to design and implement P/PI/PID controllers to achieve desired performance for SISO processes.											II	K3	1,2,3	1
C315V5.3	Ability to understand the techniques of Tuning processes											II	K2	1,2	1
C315V5.4	Ability to understand and use different single-loop control and model based controlschemes.											III	K2	1,2	1
C315V5.5	Ability to analyze and design multivariable and multi-loop control systems.											IV	K2	1,2	1
C315V5.6	Ability to understand the various processes namely four-tank system, pH process,bioreactor, distillation column.											V	K2	1,2	1
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**		**PSO1**	**PSO2**
C315V5.1	2	1	-	-	-	-	-	-	-	-	-	-		1	-
C315V5.2	3	2	1	-	-	-	-	-	-	-	-	-		2	-
C315V5.3	2	1	-	-	-	-	-	-	-	-	-	-		1	-
C315V5.4	2	1	-	-	-	-	-	-	-	-	-	-		1	-
C315V5.5	2	1	-	-		-	-	-	-	-	-	-		1	-
C315V5.6	2	1	-	-	-	-	-	-	-	-	-	-		1	-

20EEV46	DATA STRUCTURES AND ALGORITHMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the concepts of ADTs
- To understand the basics of algorithm analysis
- To Learn linear data structures – lists, stacks, and queues
- To apply Tree and Graph structures
- To understand sorting, searching and hashing algorithms and their analysis.

PRE-REQUISITE:

Course Code: 20CS201
Course Name: Programming in C

UNIT - I INTRODUCTION TO DATA STRUCTURES AND ALGORITHM ANALYSIS 10

Introduction: Data Structures, Notion of an algorithm, Algorithm Efficiency and Analysis Framework, Asymptotic Notations and their properties. Linear Data Structures: Abstract Data Types (ADTs) – List ADT – Array-based implementation – Linked list implementation —Singly Linked Lists- Circularly Linked Lists- Doubly-Linked Lists – Applications of Lists –Polynomial Manipulation – All operations (Insertion, Deletion, Merge, Traversal). Implementation of algorithmic problems.

UNIT - II LINEAR DATA STRUCTURES – STACKS, QUEUES 8

Stack ADT – Operations – Applications– Evaluating arithmetic expressions- Conversion of Infix to postfix expression – Queue ADT – Operations – Circular Queue – Priority Queue – deQueue – Applications of Queues.

UNIT - III NON LINEAR DATA STRUCTURES – TREES 9

Tree ADT – Tree Traversals – Binary Tree ADT – Expression Trees – Applications of Trees – Binary Search Tree ADT –Threaded Binary Trees- AVL Trees – B-Tree – B+ Tree – Heap – Applications of heap.

UNIT - IV NON LINEAR DATA STRUCTURES – GRAPHS 9

Definition – Representation of Graph – Types of graph – Breadth-first traversal – Depth-first traversal – Topological Sort – Bi-connectivity – Cut vertex – Euler circuits – Applications of graphs.

UNIT - V SEARCHING, SORTING AND HASHING TECHNIQUES 9

Divide and Conquer Methodology: Comparison of Searching Techniques: Linear Search – Binary Search, Mathematical analysis of Binary Search. Sorting – Merge Sort, Quick Sort, Bubble sort – Selection sort – Insertion sort – Shell sort – Radix sort. Hashing- Hash Functions – Separate Chaining – Open Addressing – Rehashing – Extendible Hashing.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Mark Allen Weiss, — Data Structures and Algorithm Analysis in C, 2nd Edition Reprint, Pearson Education, 2002.
2. Reema Thareja, — Data Structures Using C, Second Edition, Oxford University Press, 2011.
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest, Clifford Stein – Introduction to Algorithms, MIT Press, Third Edition, 2009.

REFERENCES:

1. Stephen G. Kochan, —Programming in C, 3rd edition, Pearson Education, 2005.
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, — Fundamentals of Data Structures in C, Second Edition, University Press, 2008.

OUTCOMES:

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

Course Name : DATA STRUCTURES AND ALGORITHMS												**Course Code : 20EEV46**			
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSOs**
C315V6.1	Explain the concept of asymptotic notations and algorithmic efficiency with properties.											I	K2	1,2,8,9, 12	1
C315V6.2	Describe abstract data types and implement various algorithmic problems using arrays and linked list.											I	K2	1,2,8,9, 12	1
C315V6.3	Apply the different linear data structures like stack and queue to various computing problems.											II	K3	1,2,3,8, 9,12	1
C315V6.4	Build different types of trees and graphs and apply various operations and their applications.											III, IV	K3	1,2,3,8, 9,10,12	1
C315V6.5	Analyze different sorting and searching techniques based on time and space complexity of the algorithms designed using divide and conquer methods.											V	K4	1,2,3,4, 8,9,10, 12	1
C315V6.6	Develop suitable hashing algorithm for indexing data items into specific locations in a hash table considering collision resolution techniques.											V	K3	1,2,3,8, 9,10,12	1
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	
C315V6.1	2	1	-	-	-	-	-	1	1	-	-	2	2	-	
C315V6.2	2	1	-	-	-	-	-	1	1	-	-	2	3	-	
C315V6.3	3	2	1	-	-	-	-	1	1	-	-	2	3	-	
C315V6.4	3	2	1	-	-	-	-	1	1	1	-	2	3	-	
C315V6.5	3	3	2	1	-	-	-	1	1	1	-	2	3	-	
C315V6.6	3	2	1	-	-	-	-	1	1	1	-	2	3	-	

PROFESSIONAL ELECTIVE – V

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

OBJECTIVES:

- Causes of over voltages in Power System and protection methods.
- Breakdown phenomenon in Gas, Liquid, Vacuum, Solid and Composite Dielectrics
- Generation of high AC& DC voltages and Impulse voltage & Current.
- Various methods of measurement of High Voltages and Currents.
- Testing of power apparatus and insulation coordination

PRE-REQUISITE:

Course Code: 20EE201
Course Name: Electric Circuit Analysis

UNIT-I OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS 9

Introduction to over voltages - Natural Causes of over voltages - Charge formation in the clouds – Lightning phenomenon: Mechanism of lightning stroke, Mathematical modeling of lightning - Switching surges- Reflection and Refraction of Travelling waves-Protection against over voltages.

UNIT-II ELECTRICAL BREAKDOWN IN GAS, LIQUID and SOLID DIELECTRICS 9

Gaseous breakdown - Uniform field - Townsend criterion, Streamer theory -Pachen's law - Non-uniform fields - Corona discharges - Vacuum breakdown - Conduction and breakdown in pure and commercial liquids - Breakdown mechanisms in solid dielectrics.

UNIT-III GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS 9

Generation of High DC Voltages: Voltage doubler, Cockcroft Walton Voltage multiplier and Vande-Graff generator- Generation of high AC voltages: Cascaded transformer, Resonant transformer, and Tesla coil -Generation of Impulse voltage: Single and Multistage impulse generator - MARX circuit and generation of impulse current - Tripping and control of impulse generators.

UNIT- IV MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS 9

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

UNIT-V HIGH VOLTAGE TESTING OF ELECTRICAL APPARATUS 9

Terminologies and Definitions - High voltage testing of electrical power apparatus as per standards: Insulators, Bushings, Isolators, Circuit Breakers, Cables, Transformers, and Surge Arrester - Insulation Coordination.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Naidu M.S. and Kamaraju V., "High Voltage Engineering", McGraw Hill, 6th Edition, 2020.
2. Wadhwa C.L., "High Voltage Engineering'', New age publishers, 3rd Edition, 2012.
3. Kuffel E. and Zaengl W.S., "High Voltage Engineering Fundamentals", Pergamon press, Oxford, London, 2005.

REFERENCES:

1. L.L. Alston, 'High Voltage Technology', Oxford University Press, First Indian Edition,2011.
2. Mazen Abdel – Salam, Hussein Anis, Ahdab A-Morshedy, Roshday Radwan, High Voltage Engineering – Theory &Practice, Second Edition Marcel Dekker, Inc., 2010
3. Subir Ray,' An Introduction to High Voltage Engineering' PHI Learning Private Limited, New Delhi, Second Edition, 2013.

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

Course Name : HIGH VOLTAGE ENGINEERING											**Course Code : 20EEV51**			
CO	**Course Outcomes**										**Unit**	**K –CO**	**POs**	**PSOs**
C4V51.1	Identify the causes of over voltage and its effects in power system.										I	K2	1,2	1
C4V51.2	Explain the breakdown Mechanisms in Solid, Liquid, gases and Composite dielectrics.										II	K2	1,2	1
C4V51.3	Analyze different type of Generating circuit for high voltage D.C and high voltage A.C.										III	K4	1,2,5	1
C4V51.4	Explain the Measurement of A.C and D.C high voltage and current using appropriate method.										IV	K2	1,2,5	1
C4V51.5	Analyze the importance of power apparatus testing in Transient studies.										V	K4	1,2,5	1
C4V51.6	Understand the concept of Insulation coordination.										V	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	2	-	-	-	-	-	-	-	-	-	-	1	-
C4V51.2	2	2	-	-	-	-	-	-	-	-	-	-	1	-
C4V51.3	2	2	-	-	1	-	-	-	-	-	-	-	1	-
C4V51.4	2	2	-	-	1	-	-	-	-	-	-	-	1	-
C4V51.5	2	2	-	1	1	1	1	-	-	-	-	-	1	-
C4V51.6	2	2	-	-	1	-	-	-	-	-	-	-	1	-

20EEV52	SMPS AND UPS (20EE844)	L	T	P	C
		3	0	0	3

OBJECTIVES:

To impart knowledge about the following topics:

- Modern power electronic converters and its applications in electric power utility.
- Resonant converters and UPS

PRE-REQUISITE: Nil

UNIT - I DC-DC CONVERTERS 9

Principles of step down and step up converters – Analysis and state space modeling of Buck, Boost, Buck- Boost and Cuk converters.

UNIT - II SWITCHED MODEPOWER CONVERTERS 9

Analysis and state space modeling of fly back, Forward, Push pull, Luo, Half bridge and full bridge converters - control circuits and PWM techniques.

UNIT - III RESONANTCONVERTERS 9

Introduction – classification - basic concepts - Resonant switch - Load Resonant converters - ZVS , Clamped voltage topologies - DC link inverters with Zero Voltage Switching - Series and parallel Resonant inverters - Voltage control.

UNIT - IV DC-AC CONVERTERS 9

Single phase and three phase inverters, control using various (sine PWM, SVPWM and PSPWM) techniques, various harmonic elimination techniques - Multilevel inverters - Concepts - Types: Diode clamped - Flying capacitor - Cascaded types - Applications.

UNIT - V V POWER CONDITIONERS, UPS& FILTERS 9

Introduction - Power line disturbances - Power conditioners – UPS: offline UPS, Online UPS, Applications – Filters: Voltage filters, Series-parallel resonant filters, filter without series capacitors, filter for PWM VSI, current filter, DC filters – Design of inductor and transformer for PE applications – Selection of capacitors.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Simon Ang, Alejandro Oliva," Power-Switching Converters", Third Edition, CRC Press, 2010.
2. Kjeld Thorborg, "Power Electronics – In theory and Practice", Overseas Press, First Indian 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	-

20EEV53	TESTING OF ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know various standardization procedures
- To learn the testing procedures for EV & HEV components
- To know the functional safety and EMC
- To realize the effect of EMC in EVs
- To study the effect of EMI in motor drives and in DC-DC converter system

PRE-REQUISITE:

Course Code: 20EEV23
Course Name: Electric Vehicles and Power Management

UNIT - I EV STANDARDIZATION 9

Introduction – Current status of standardization of electric vehicles, electric Vehicles and Standardization - Standardization Bodies Active in the Field — Standardization activities in countries like Japan. The International Electro Technical Commission – Standardization of Vehicle Components.

UNIT - II TESTING OF ELECTRIC MOTORS AND CONTROLLERS FOR ELECTRIC AND HYBRID ELECTRIC VEHICLES 9

Test Procedure Using M-G Set, electric motor, controller, application of Test Procedure, Analysis of Test Items for the Type Test - Motor Test and Controller Test (Controller Only).- Test Procedure Using Eddy Current Type Engine Dynamometer, Test Strategy, Test Procedure, Discussion on Test Procedure. Test Procedure Using AC Dynamometer.

UNIT - III FUNDAMENTALS OF FUNCTIONAL SAFETY AND EMC 9

Functional safety life cycle – Fault tree analysis – Hazard and risk assessment — software development – Process models – Development assessments –Configuration management – Reliability - Reliability block diagrams and redundancy - Functional safety and EMC - Functional safety and quality – Standards – Functional safety of autonomous vehicles.

UNIT - IV EMC IN ELECTRIC VEHICLES 9

Introduction - EMC Problems of EVs, EMC Problems of Motor Drive, EMC Problems of DC – DC Converter System, EMC Problems of Wireless Charging System, EMC Problem of Vehicle Controller, EMC Problems of Battery Management System, Vehicle EMC Requirements

UNIT - V EMI IN MOTOR DRIVE AND DC-DC CONVERTER SYSTEM 9

Overview - EMI Mechanism of Motor Drive System, Conducted Emission Test of Motor Drive System, IGBT EMI Source, EMI Coupling Path, EMI Modelling of Motor Drive System. EMI in DC-DC Converter, EMI Source, The Conducted Emission High-Frequency, Equivalent Circuit of DC-DC Converter System, EMI Coupling Path

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005, 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	Illustrate 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	Determine the EMI in motor drive											5	K2	1,2	1
C4V53.6	Determine 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	-	

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 hands on training to understand concepts related to smart automation.
   a) Hands on experiments based on Ubidots & Thing speak / Open-source Analytics Platform
   b) Design and implementation of a smart home system.
   c) Bluetooth Based Home Automation Project using Android Phone
   d) GSM Based Home Devices Control
   e) Pick and place robots using Arduino / any suitable Embedded processor
2. Assignment: Revolution of Smart Automation system across the world and its current scope available in India
3. Mini project: Design of a Smart Automation system (for any application of students choice)

TOTAL: 30+30 = 60 PERIODS

TEXT BOOKS:

1. Grimm, Christoph, Neumann, Peter, Mahlknechand Stefan, Embedded Systems for Smart Appliances and Energy Management, Springer 2013, 1st Edition
2. Kazem Sohraby, Daniel Minoli and Taieb Znati, Wireless Sensor Networks Technology, Protocols, and Applications, John Wiley & Sons, 2007, 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	K3	1,2,3,6,8, 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	K3	1,2,3,6,8, 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	Design the Embedded processor based pick and place robot and Mobile Robot. Illustrate 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	3	2	1	-	-	2	-	2	2	1	-	-	2	2
C4V54.3	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

20EEV55	COMPUTER CONTROL OF PROCESSES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To represent the linear time invariant System in discrete State Space form
- To analyze the controllability, observability and stability of a Discrete time System.
- To estimate model parameters from input/output measurements
- To Design Digital Controllers
- To Design Multi-loop and Multivariable Controllers for multivariable system

PRE-REQUISITE: Nil

UNIT - I DISCRETE STATE-VARIABLE TECHNIQUE 9

State equation of discrete data system with sample and hold – State transition equation – Methods of computing the state transition matrix – Decomposition of discrete data transfer functions – State diagrams of discrete data systems – System with zero-order hold –Controllability and observability of linear time invariant discrete data system–Stability tests of discrete-data system

UNIT - II SYSTEM IDENTIFICATION 9

Identification of Non-Parametric Input-Output Models: - Transient analysis - Frequency analysis – Correlation analysis – Spectral analysis – Identification of Parametric Input-Output Models: -Least Squares Method – Recursive Least Square Method.

UNIT - III DIGITAL CONTROLLER DESIGN 9

Review of z-transform – Modified of z-transform – Pulse transfer function – Digital PID controller – Dead-beat controller and Dahlin's controller – Kalman's algorithm, Pole Placement Controller

UNIT - IV MULTI-LOOP REGULATORY CONTROL 9

Multi-loop Control - Introduction – Process Interaction – Pairing of Inputs and Outputs – The Relative Gain Array (RGA) – Properties and Application of RGA - Multi-loop PID Controller – Biggest Log Modulus Tuning Method – De-coupler.

UNIT - V MULTIVARIABLE REGULATORY CONTROL 9

Introduction to Multivariable control – Multivariable PID Controller – Multivariable Dynamic Matrix Controller – Case Studies:-Distillation Column, CSTR and Four-tank system.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Stephanopoulos,G., "Chemical Process Control-An Introduction to Theory and Practice", Prentice Hall of India, 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	1,2,3,4,	1,2
C4V55.2	Construct models from input-output data by least square and recursive least square method.										2	K2	1,2,3,4	1,2
C4V55.3	Ability to design different digital controllers to satisfy the required criterion.										3	K3	1,2,3,4	1,2
C4V55.4	Design a multi-loop controller and multivariable controller for multi-variable systems.										4	K3	1,2,3,4	1,2
C4V55.5	Ability to design multivariable dynamic matrix controller for industrial processes.										5	K4	1,2,3,4	1,2
C4V55.6	Ability to case studies on future implementation on controller design.										5	K3	1,2,3,4	1,2
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C4V55.1	3	3	3	2	1	-	-	-	-	-	1	-	2	1
C4V55.2	3	3	3	3	1	-	-	-	-	-	1	-	2	1
C4V55.3	3	3	3	3	1	-	-	-	-	-	1	-	2	1
C4V55.4	3	3	3	3	1	-	-	-	-	-	1	-	2	1
C4V55.5	3	3	3	3	1	-	-	-	-	-	1	-	2	1
C4V55.6	3	3	3	3	1	-	-	-	-	-	1	-	2	1

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	-	-	

PROFESSIONAL ELECTIVE – VI

		L	T	P	C
20EEV61	ELECTRIC ENERGY GENERATION, UTILIZATION AND CONSERVATION (20EE8A4)	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: Nil

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	K4	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	1	-	-	-	-	-	-	-	-	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		

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

OBJECTIVES: To impart knowledge on the following Topics

- To learn the various types of renewable sources of energy.
- To understand the electrical machines to be used for wind energy conversion systems.
- To learn the principles of power converters used in solar PV system.
- To study the principle of power converters used in Wind system.
- To simulate the AC-DC,AC-AC Converters, Matrix Converters and PWM Inverters

PRE-REQUISITE:

Course Code: 20EE502, 20EE702

Course Name: Power Electronics, Renewable Energy Systems

UNIT - I INTRODUCTION TO RENEWABLE ENERGY SYSTEMS 9

Classification of Energy Sources — Importance of Non-conventional energy sources — Advantages and disadvantages of conventional energy sources-Environmental aspects of energy – Impacts of renewable energy generation on the environment-Qualitative study of renewable energy resources: Ocean energy, Bio-mass energy, Hydrogen energy-Solar Photovoltaic (PV),Fuel cells: Operating principles and characteristics, Wind Energy: Nature of wind, Types, control strategy, operating area.

UNIT - II ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS 9

Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG)-Permanent Magnet Synchronous Generator (PMSG).

UNIT - III POWER CONVERTERS AND ANALYSIS OF SOLAR PV SYSTEMS 9

Power Converters: Line commutated converters (inversion-mode)-Boost and buck-boost converters-selection of inverter, battery sizing, array sizing. Simulation of line commutated converters, buck/boost converters. Analysis: Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems, Grid integrated solar PV Systems - Grid Connection Issues.

UNIT - IV POWER CONVERTERS FOR WIND SYSTEMS 9

Power Converters: Three-phase AC voltage controllers-AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid-Interactive Inverters- Matrix converter.

UNIT - V HYBRID RENEWABLE ENERGY SYSTEMS 9

Need for Hybrid Systems - Range and type of Hybrid systems - Case studies of Diesel - PV, Wind - PV, Micro hydel - PV, Biomass - Diesel systems - Maximum Power Point Tracking (MPPT).

TOTAL: 45 PERIODS

TEXT BOOKS:

1. S.N.Bhadra, D.Kastha, & S.Banerjee “Wind Electrical Systems”, Oxford University Press, 2009, 7th impression
2. Rashid.M.H “Power electronics Handbook”, Academic press, 2nd Edition, 4th Edition ,

2017
3. Joshua Earnest, Tore Wizeliu, 'Wind Power Plants and Project Development', PHI Learning Pvt.Ltd, New Delhi, 2011
4. D.P.Kothari, K.C Singal, Rakesh Ranjan "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt. Ltd, New Delhi, 2013
5. Rai.G.D, "Solar energy utilization", Khanna publishers, 5th Edition, 2008
6. Rai G.D., Non-Conventional Energy Sources, Khanna Publishers, 2011
7. H.Khan, "Non-conventional Energy sources", Tata McGraw-hill Publishing Company, New Delhi, 2017, 3rd Edition.
8. Gray, L.Johnson, "Wind energy system", prentice hall of India, 2nd Edition, 2006.

REFERENCES:

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

OUTCOMES:

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

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	1,2,3,4	1
C4V62.2	Analyze the performance of IG,PMSG,SCIG AND DFIG										2	K4	1,2,3,4	1
C4V62.3	Analyze different power converters namely AC to DC,DC to DC and Ac to AC converters for renewable energy sources										3	K4	1,2,3,4	1
C4V62.4	Analyze various operating modes of wind electrical generators and solar energy systems										4	K4	1,2,3,4	1
C4V62.5	Analyze various operating modes of solar energy systems										4	K4	1,2,3,4	1
C4V62.6	Develop maximum power point tracking algorithms										5	K4	1,2,3,4	1
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C4V62.1	3	2	1	-	-	-	-	-	-	-	-	-	1	-
C4V62.2	3	2	1	-	-	-	-	-	-	-	-	-	1	-
C4V62.3	3	2	1	-	-	-	-	-	-	-	-	-	1	-
C4V62.4	3	2	1	-	-	-	-	-	-	-	-	-	1	-
C4V62.5	3	2	1	-	-	-	-	-	-	-	-	-	1	-
C4V62.6	3	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

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	Demonstrate the impact of EV and V2G on smart grid system											IV	K2	1,2	-
C4V63.5	Demonstrate 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	-	

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: 30+30 = 60 PERIODS

TEXT BOOKS:

1. William B. Ribbens, “Understanding Automotive Electronics”, Elseiver, 8th Edition, 2017.
2. Jurgen, R., “Automotive Electronics Hand Book”, McGraw Hill, 2nd Edition, 1999.
3. L.Vlacic, M.Parent, F.Harahima, ”Intelligent Vehicle Technologies”, SAE International, 2001,1st Edition, 2017.

REFERENCES:

1. Ali Emedi, 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

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-Hill Singapore, 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

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:NIL

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, 4th Edition, 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	-	-	-	-	-	-	-	-	-	-	-	-

20EEV71	UNDER GROUND CABLE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart knowledge on the following topics

- Understanding Power Cable Characteristics and Applications.
- Cable Manufacturing.
- Installation of underground power cables
- Underground cable System Fault Locating.
- Testing and maintenance of Underground cable system.
- Cable Performance and Field Assessment of Power Cables

PRE-REQUISITE: Nil

UNIT - I INTRODUCTION TO ELECTRICAL POWER CABLES 9

Development of Underground Cables – Electric Lighting – Distribution of Energy for Lighting – Paper Insulated Cables – Underground Residential Distribution Systems – Medium Voltage Cable Development.

UNIT - II CABLE ARCHITECHTURE, DIELECTRIC THEORY AND CABLE CHARACTERISTICS 9

Architecture of Underground Cabling System – Basic Dielectric Theory of Cable – Conductors – Armourand 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 and 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 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

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

OBJECTIVES: To impart knowledge on the following Topics

- 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 *MULTILEVELINVERTERS 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 MULTI LEVEL CONVERTER 9

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

UNIT - V MULTI LEVEL 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	Examine the different topologies of multi level inverters (MLIs) with and without DC link capacitor											1	K3	1,2,3,9	1
C4V72.2	Examine the performance of MLI switch Bipolar Pulse Width Modulation (PWM) Unipolar PWM Carrier-Based PWM Schemes Phase Level Shifted Multi carrier Modulation											2	K3	1,2,3,9	1
C4V72.3	Demonstrate the working principles of Cascaded H-Bridge MLI, diode clamped MLI, flying capacitor MLI and MLI with reduced switch count											3	K3	1,2,3,9	1
C4V72.4	Analyze the voltage balancing performance in Diode clamped MLI.											4	K3	1,2,3,9	1
C4V72.5	Simulate three level, capacitor clamed and diode clamped MLI with R and RL load											4	K3	1,2,3,9	1
C4V72.6	Simulate MLI with reduced switch configuration using fundamental switching scheme											5	K3	1,2,3,9	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	-	-	-		1	-
C4V72.2	3	2	1	-	-	-	-	-	1	-	-	-		1	-
C4V72.3	3	2	1	-	-	-	-	-	1	-	-	-		1	-
C4V72.4	3	2	1	-	-	-	-	-	1	-	-	-		1	-
C4V72.5	3	2	1	-	-	-	-	-	1	-	-	-		1	-
C4V72.6	3	2	1	-	-	-	-	-	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	Design 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	Design and implement of fuzzy logic control scheme for BLDC motor using FPGA in real time.										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	-

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	-	-	-	-	-	-	-	-	-	-	-	-

20EEV75	MACHINE MONITORING SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To make the students familiarize with the concept of condition-based maintenance for effective utilization of machines.
- To Impart the knowledge of artificial intelligence for machinery fault diagnosis.
- To give basic knowledge on vibration monitoring.
- To study the machinery vibrations using signal processing techniques.
- To provide knowledge on FMECA.

PRE-REQUISITE: Nil

UNIT-I INTRODUCTION TO MACHINE CONDITION MONITORING 9

Machinery condition monitoring - Present status - Fault prognosis - Future needs.

UNIT-II MACHINERY MAINTENANCE 9

Maintenance strategies – Reactive, Preventive, and Predictive – Benefits of planned maintenance – Bath tub curve – Failure Modes Effects and Criticality Analysis (FMECA).

UNIT-III INTRODUCTION TO MACHINERY VIBRATION AND MONITORING 9

Characteristics of Vibration systems – Mode shapes & operational deflection shapes – Experimental modal analysis – Principles of vibration monitoring – Machinery faults diagnosed by vibration analysis.

UNIT- IV SIGNAL PROCESSING IN MACHINERY MONITORING 9

FFT analysis – Time domain analysis – Time-frequency analysis – Signal filtering – Cepstrum analysis – Health condition of compressor & engine.

UNIT-V MACHINE LEARNING FOR CONDITION MONITORING 9

Machine Learning: Feature extraction and feature selection methods – Feature reduction – Classification techniques – Case studies of condition monitoring in Nuclear plant components, Distillation column.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Cornelius Scheffer and Paresh Girdhar, “Practical Machinery Vibration Analysis and Predictive Maintenance”, Elsevier, 2004, 1st Edition.
2. A. R. Mohanty, “Machinery Condition Monitoring: Principles and Practices”, CRC Press, Taylor & Francis, 1st Edition, 2017.

REFERENCES:

1. Stephen Marsland, Machine Learning: An Algorithmic Perspective, 2nd Edition, 2014, CRC, Press.

2. Collacot, “Mechanical Fault Diagnosis and Condition Monitoring”, Chapman- Hall, 1st Edition, 2011.
3. Davies, “Handbook of Condition Monitoring – Techniques and Methodology”, Springer, 1st Edition, 2011.

OUTCOMES:

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

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	1,2,3,4,5	1,2
C4V75.2	Choose the proper maintenance strategies and condition monitoring techniques for identification of failure in a machine L3.										2	K3	1,2,3,4	1,2
C4V75.3	Construct a classifier model for machine learning based fault diagnosis L5.										3	K3	1,2,3,4	1,2
C4V75.4	Predict the faulty component in a machine by analyzing the acquired vibration signals L2.										4	K2	1,2,3,4	1,2
C4V75.5	Analyze & build a model using modern tools L4.										5	K4	1,2,3,4	1,2
C4V75.6	Understand the concept of Machine learning										5	K2	1,2,3,4	1,2
CO-PO Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C4V75.1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
C4V75.2	3	2	2	2	1	1	1	1	1	1	1	1	1	2
C4V75.3	3	3	3	3	1	1	1	1	1	1	1	1	1	2
C4V75.4	2	2	1	2	1	1	1	1	1	1	1	1	1	2
C4V75.5	3	3	3	2	1	1	1	1	1	1	1	1	1	2
C4V75.6	3	3	3	2	1	1	1	1	1	1	1	1	1	2

20EEV76	ENERGY STORAGE SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

Students will be able to:

- Understand the various types of energy storage Technologies.
- Analyze thermal storage system.
- Analyze different battery storage technologies
- Analyze the thermodynamics of Fuel Cell
- Study the various applications of energy storage systems

UNIT-I INTRODUCTION 9

Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications.

UNIT-II THERMAL STORAGE SYSTEM 9

Thermal storage – Types – Modeling of thermal storage units – Simple water and rock bed storage system – pressurized water storage system – Modelling of phase change storage system – Simple units, packed bed storage units - Modelling using porous medium approach, Use of TRNSYS.

UNIT-III ELECTRICAL ENERGY STORAGE 9

Fundamental concept of batteries – measuring of battery performance, charging and discharging, power density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel – Cadmium, Zinc Manganese dioxide, Li-ion batteries - Mathematical Modelling for Lead Acid Batteries – Flow Batteries.

UNIT- IV FUEL CELL 9

Fuel Cell – History of Fuel cell, Principles of Electrochemical storage – Types – Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis – advantages and disadvantages.

UNIT-V ALTERNATE ENERGY STORAGE TECHNOLOGIES 9

Flywheel, Super capacitors, Principles & Methods – Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications, Pumped Hydro Storage – Applications.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Ibrahim Dincer and Mark A. Rosen, 'Thermal Energy Storage Systems and Applications', John Wiley & Sons, 3rd Edition, 2021.
2. Ru-shi Liu, Lei Zhang and Xueliangsun, 'Electrochemical technologies for energy storage and conversion', Wiley publications, 2nd Volume set ,2012.
3. James Larminie and Andrew Dicks, 'Fuel cell systems Explained', Wiley publications, 3rd Edition, 2018.

REFERENCES:

1. Lunardini.V.J, 'Heat Transfer in Cold Climates', John Wiley and Sons 1981, 1st Edition.
2. Schmidt.F.W. and Willmott.A.J., 'Thermal Energy Storage and Regeneration', Hemisphere Publishing Corporation, 1981, 1st Edition.

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

Course Name : ENERGY STORAGE SYSTEMS		Course Code :20EEV76			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C4V76.1	Understand different types storage technologies	1	K2	1,2	1
C4V76.2	Design a thermal storage system	2	K4	1,3	1
C4V76.3	Analyze the thermodynamics of fuel cell	3	K4	1,3	1
C4V76.4	Predict the faulty component in a machine by analyzing the acquired vibration signals L2.	4	K2	1,3	1
C4V76.5	Analyze the appropriate storage technologies for different applications	5	K4	1,3	1
C4V76.6	Explore the alternate energy storage technologies.	5	K3	2,6,8	1

CO-PO mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C4V76.1	3	1		-	-	-	-	-	-	-	-	-	2	-
C4V76.2	3	-	2	-	-	-	-	-	-	-	-	-	2	-
C4V76.3	3	-	2	-	-	-	-	-	-	-	-	-	2	-
C4V76.4	3	-	2	-	-	-	-	-	-	-	-	-	2	-
C4V76.5	3	-	2	-	-	-	-	-	-	-	-	-	2	-
C4V76.6	-	3	-	-	-	2	-	1	-	-	-	-	2	-

20EEV81	SUBSTATION ENGINEERING AND AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To help engineering students to have a holistic understanding of the concepts behind substation engineering and design.
- The course aims to give an exposure to the students to the requirements of practical aspects including an overview of civil and mechanical aspects.
- Course aims to enhance the knowledge, and give the practical guidelines for site selection, construction, protection along with maintenance, safety in a substation.
- It also aims at providing knowledge about state-of-the-art technology in substation automation system
- To help engineering students to have a holistic understanding of the concepts behind substation engineering and design.

PRE-REQUISITE: Nil

UNIT-I SUBSTATION DESIGN DEVELOPMENT 9

Substation Introduction and Classifications, Different bus bar switching schemes for Substation. Standards and Practices, Factors Influencing Substation Design - Altitude, Ambient Temperature, Earthquake and seismic zones, pollution and corrosion etc., Testing of Electrical Equipment, Concept and development of Single Line Diagram. Requirement of substation calculation.

UNIT-II SUBSTATION EQUIPMENT 9

Selection and sizing of main substation equipment: Transformer, Isolator, Circuit Breaker, surge arrestor, Instrument transformers, classification of equipment with a practical overview, and the performance parameters. Classifications of MV Switchgear and Key Design Parameters, MV/LV Switchgear construction and design of control scheme. Station Auxiliary equipment: Diesel Generator System, Basics of AC/DC Auxiliary Power System & Sizing of Aux. Transformer, DC System Components, Battery Sizing & charger Sizing, DG Set Classification, and sizing. Introduction to gas insulated substation: Operating principle of GIS, Advantage over AIS, construction of GIS

UNIT-III PROTECTION AND SUBSTATION AUTOMATION 9

Power System protection, Overcurrent and Earth Fault protection and coordination. Distribution Feeder Protection, Transformer – Unit/Main Protection, Familiarization of NUMERICAL Relays, distance/differential protection for transmission line. Substation Automation: Evolution of Substation Automation, Communication System Fundamentals-Protocol fundamental and choosing the right protocol. Substation integration and automation functional architecture, Substation signal list - DI, DO, AI, AO– Bay Control Unit (BCU), Remote Terminal Unit RTU.

UNIT- IV SUBSTATION DESIGN & LAYOUT ENGINEERING 9

Layout aspects of Outdoor Air Insulated Substation and GIS: Statutory Clearances, Equipment Layout engineering aspects for Outdoor Substation/GIS and related calculations, and guide lines, Cable routing layout, Erection Key Diagram (EKD), switchyard earthing design as per IEEE80, Importance and Types of Earthing, Earthing Design, Types of Earthing Material, Direct stroke

Lightning Protection for switchyard with IS/ IEC 62305. LV Cables - Power & Control, MV Cables, Methods for Cable Installation, Practical aspects of Cable Sizing, Cable accessories, Illumination System Design.

UNIT-V INTERFACE ENGINEERING 9

Civil & Structural Engineering - Familiarization of site development plan, equipment supports structures, foundation for equipment, familiarization of control building and substation building, infrastructure development, Mechanical System- Fire Detection, Alarm System and Fire Suppression System for transformer, Heating, Ventilation and Air-conditioning (HVAC) for Substation

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Ibrahim Dincer and Mark A. Rosen, 'Thermal Energy Storage Systems and Applications', John Wiley & Sons, 3rd Edition, 2021.
2. Ru-shiLiu, Lei Zhang and Xueliangsun, 'Electrochemical technologies for energy storage and conversion', Wiley publications, 2nd Volume set, 2012.
3. James Larminie and Andrew Dicks, 'Fuel cell systems Explained', Wiley publications, 3rd Edition, 2018.

REFERENCES:

1. Lunardini.V.J, 'Heat Transfer in Cold Climates', John Wiley and Sons 1981, 1st Edition.
2. Schmidt.F.W. and Willmott.A.J., 'Thermal Energy Storage and Regeneration', Hemisphere Publishing Corporation, 1981, 1st Edition.

OUTCOMES:

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

Course Name: SUBSTATION ENGINEERING AND AUTOMATION												Course Code: 20EEV81			
CO	**Course Outcomes**											**Unit**	**K –CO**	**POs**	**PSOs**
C4V81.1	Understand the key deciding factors involved in substation design and operation.											1	K2	1,2,3,5,6 ,7,8,12	1
C4V81.2	Know about 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	Know 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	Understand about Interdisciplinary aspects involved in substation design											4	K2	1,2,3,6,7 ,8,9,12	1
C4V81.5	Understand different protection and control scheme involved in substation design											4	K2	1,2,3,4,6 ,7,8,9,12	1
C4V81.6	Know 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	-

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

OBJECTIVES: To impart knowledge on the following Topics

- 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
Course Name: Power Electronics

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	1,2,3,9	1
C4V82.2	Illustrate the effect of poles and zero's in the 's' plane.											2	K3	1,2,3,9	1
C4V82.3	Select Symbolic equations for solving problems related with Matrices, Polynomial and vectors.											3	K3	1,2,3,9	1
C4V82.4	compute the control expression for DC–DC buck converter using sliding mode control theory											4	K3	1,2,3,9	1
C4V82.5	Determine the controller expression for power factor correction circuits.											4	K3	1,2,3,9	1
C4V82.6	Simulate sliding mode control of buck converter and power factor correction circuit.											5	K3	1,2,3,9	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	-	-	-		1	-
C4V82.2	3	2	1	-	-	-	-	-	1	-	-	-		1	-
C4V82.3	3	2	1	-	-	-	-	-	1	-	-	-		1	-
C4V82.4	3	2	1	-	-	-	-	-	1	-	-	-		1	-
C4V82.5	3	2	1	-	-	-	-	-	1	-	-	-		1	-
C4V82.6	3	2	1	-	-	-	-	-	1	-	-	-		1	-

20EEV83	DESIGN OF ELECTRICAL APPARATUS (20EE6A2)	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Magnetic circuit parameters and thermal rating of various types of electrical machines.
- Armature and field systems for D.C. machines.
- Core, yoke, windings and cooling systems of transformers.
- Design of stator and rotor of induction machines.
- Design of stator and rotor of synchronous machines.

PRE-REQUISITE:

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

UNIT-I DESIGN OF FIELD SYSTEM AND ARMATURE 9

Major considerations in Electrical Machine Design – Design factors-Limitations in Design-Electrical Engineering materials –Design of Magnetic circuits – Magnetizing current – Flux leakage – Leakage in Armature. Design of lap winding and wave winding.

UNIT-II DESIGN OF TRANSFORMERS 9

Construction - KVA output for single and three phase transformers – Overall dimensions design of yoke, core and winding for core and shell type transformers – Estimation of No load current – Temperature rise in Transformers – Design of Tank and cooling tubes of Transformers. Computer program: Complete Design of single phase core type transformer.

UNIT-III DESIGN OF DC MACHINES 9

Construction - Output Equations – Main Dimensions – Choice of specific loadings –Selection of number of poles – Design of Armature – Design of commutator and brushes design of field - Computer program: Design of Armature main dimensions.

UNIT- IV DESIGN OF INDUCTION MOTORS 9

Construction - Output equation of Induction motor – Main dimensions – choice of specific loadings – Design of squirrel cage rotor and wound rotor –Magnetic leakage calculations –Operating characteristics : Magnetizing current - Short circuit current – Circle diagram -Computer program: Design of slip-ring rotor

UNIT- V DESIGN OF SYNCHRONOUS MACHINES 9

Output equation – choice of specific loadings – Design of salient pole machines – Shortcircuit ratio – Armature design – Estimation of air gap length – Design of rotor –Design of damper winding – Determination of full load field MMF – Design of turbo alternators -Computer program: Design of Stator main dimensions.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Sawhney, A.K., 'A Course in Electrical Machine Design', Dhanpat Rai & Sons, New Delhi, Fifth Edition, 2016.
2. M V Deshpande 'Design and Testing of Electrical Machines' PHI learning Pvt Lt, 2011.
3. Sen, S.K., 'Principles of Electrical Machine Designs with Computer Programmes', Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2009.

REFERENCES:

1. A.Shanmugasundaram, G.Gangadharan, R.Palani 'Electrical Machine Design Data Book', New Age International Pvt. Ltd., Reprint 2007.
2. Balbir Singh, 'Electrical Machine Design', Vikas Publishing House Private Limited, 1981.
3. V Rajini, V.S Nagarajan, 'Electrical Machine Design', Pearson, 2017.
4. K.M.Vishnumurthy, 'Computer aided design of electrical machines', B 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	Explain the design considerations for rotating and static electrical machines.										I	K3	1,2,3	2
C4V83.2	Design 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	Design armature and field of DC machines.										III	K3	1,2,3	2
C4V83.5	Design stator and rotor of induction motor.										IV	K3	1,2,3	2
C4V83.6	Design 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	3	1	-	-	-	-	-	-	-	-	-	-	2
C4V83.6	3	2	1	-	-	-	-	-	-	-	-	-	-	2

20EEV84	MEMS AND NEMS	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To introduce the diverse technological and functional approaches of MEMS/NEMS and applications.
- To understand the microstructures and fabrication methods.
- To provide an insight of micro and nano sensors, actuators.
- To emphasis the need for NEMS technology.
- To update the ongoing trends and real time applications of MEMS and NEMS technology.

PRE-REQUISITE: Nil

UNIT - I INTRODUCTION TO MEMS and NEMS 6

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

UNIT - II MICRO-MACHINING AND MICRO FABRICATION TECHNIQUES 6

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

UNIT - III MICRO SENSORS AND MICRO ACTUATORS 6

Micro machining: Capacitive Sensors – Piezoresistive Sensors – Piezoelectric actuators.

UNIT - IV NEMS TECHNOLOGY 6

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

UNIT - V MEMS and NEMS APPLICATION 6

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

30 PERIODS

LAB COMPONENTS: 30 PERIODS

1. Laboratory experiment: Simulation of MEMS sensors and actuators using Multi physics tool
   a) Simulation of a typical piezoresistive sensor
   b) Simulation of a typical Piezoelectric actuator
   c) Simulation study of a biosensor
   d) Simulation study of a micro motor
2. Assignment: Role of MEMS and NEMS devices for Industry Standard 5.0.
3. Mini project: Design and analysis of any MEMS/NEMS device using multi physics tool.

TOTAL: 30+30 = 60 PERIODS

TEXT BOOKS:

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

REFERENCES:

1. Marc F madou “Fundamentals of micro fabrication” CRC Press 2002 2nd Edition Marc Madou.
2. M.H.Bao “Micro mechanical transducers: Pressure sensors, accelerometers and gyroscopes”, Elsevier, Newyork, 16 Oct 2000,1stEdition.
3. Maluf, Nadim “An introduction to Micro Electro-mechanical Systems Engineering“ AR Tech house, Boston, June 30 2004, 2nd Edition.
4. Mohamed Gad– el –Hak “MEMS Handbook” Edited CRC Press 2001,1st Edition.

LIST OF OPEN SOURCE SOFTWARE / LEARNING WEBSITE:

1. https://www.academia.edu/Lectures_on_MEMS_and_MICROSYSTEMS_DESIGN_AND_MANUFACTURE
2. https://nptel.ac.in/courses
3. https://www.iitk.ac.in/me/mems-fabrication
4. http://mems.iiti.ac.in/
5. https://onlinecourses.nptel.ac.in/noc22_ee36/preview

OUTCOMES:

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

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		

20EEV85	MODEL BASED CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the Knowledge about Multivariable and Multi loop systems.
- To understand the Model predictive control schemes and its elements.
- Get exposed to state space MPC along with case studies.
- To acquire knowledge on various constrained MPC.
- To make the student understand the principles of STR, MRAC and Gain scheduling.
- To make the student design simple adaptive controllers for linear systems

PRE-REQUISITE: NIL

UNIT - I INTRODUCTION TO MIMO CONTROL 9

Introduction to MIMO Systems – Multivariable control – Multiloop Control – MultivariableI 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	Ability to apply engineering knowledge to understand the control schemes on MIMO systems											1	K2	1,2,3,4,	1,2
C4V85.2	Ability to design controller for MIMO system											2	K3	1,2,3,4	1,2
C4V85.3	Ability to analyze the control schemes available in industries											3	K3	1,2,3,4	1,2
C4V85.4	Ability to design MPC, Adaptive controllers for practical engineering problems											4	K3	1,2,3,4	1,2
C4V85.5	Ability to choose suitable controllers for the given problems											5	K2	1,2,3,4	1,2
C4V85.6	Ability to apply case studies on advanced controller for future implementation.											5	K2	1,2,3,4	1,2
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	
C4V85.1	3	2	2	2	1	-	-	-	1	-	1	-	2	1	
C4V85.2	3	3	3	3	1	-	-	-	1	-	1	-	2	1	
C4V85.3	3	3	3	2	1	-	-	-	1	-	1	-	2	1	
C4V85.4	3	3	3	3	1	-	-	-	1	-	1	-	2	1	
C4V85.5	2	3	3	3	1	-	-	-	1	-	1	-	2	1	
C4V85.6	2	3	3	3	1	-	-	-	1	-	1	-	2	1	

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 basic probability theory concepts.										1	K3	1,2,3,8,9	-
C4V86.2	Calculate the statistical measures for two dimensional random variables.										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	-	-	-	-	-

VERTICAL 1: FINTECH AND BLOCK CHAIN

20MGV11	FINANCIAL MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To acquire the knowledge of the decision areas in finance.
- To learn the various sources of Finance
- To describe about capital budgeting and cost of capital.
- To discuss on how to construct a robust capital structure and dividend policy
- To develop an understanding of tools on Working Capital Management

PRE-REQUISITE: NIL

UNIT - I THE INVESTMENT ENVIRONMENT 9

Definition and Scope of Finance Functions - Objectives of Financial Management - Profit Maximization and Wealth Maximization- Time Value of money- Risk and return concepts.

UNIT – II SOURCES OF FINANCE 9

Long term sources of Finance -Equity Shares – Debentures - Preferred Stock – Features – Merits and Demerits. Short term sources - Bank Sources, Trade Credit, Overdrafts, Commercial Papers, Certificate of Deposits, Money market mutual funds etc

UNIT – III INVESTMENT DECISIONS 9

Investment Decisions: capital budgeting – Need and Importance – Techniques of Capital Budgeting– Payback -ARR – NPV – IRR –Profitability Index.

Cost of Capital - Cost of Specific Sources of Capital - Equity -Preferred Stock- Debt - Reserves -Concept and measurement of cost of capital - Weighted Average Cost of Capital.

UNIT – IV FINANCING AND DIVIDEND DECISION 9

Operating Leverage and Financial Leverage- EBIT-EPS analysis. Capital Structure – determinantsof Capital structure- Designing an Optimum capital structure .

Dividend policy - Aspects of dividend policy - practical consideration - forms of dividend policy -Determinants of Dividend Policy

UNIT - V WORKING CAPITAL DECISION 9

Working Capital Management: Working Capital Management - concepts - importance - Determinants of Working capital. Cash Management: Motives for holding cash – Objectives and Strategies of CashManagement. Receivables Management: Objectives - Credit policies.

TOTAL: 45 PERIODS

TEXT BOOKS:

1.M.Y. Khan and P.K.Jain Financial management, Text, Tata McGraw Hill

2. M. Pandey Financial Management, Vikas Publishing House Pvt. Ltd

REFERENCES:

1.James C. Vanhorne –Fundamentals of Financial Management– PHI Learning

2.Prasanna Chandra, Financial Management

3. Srivatsava, Financial Management, Oxford University Press, 2011

20MGV21	FUNDAMENTALS OF INVESTMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Describe the investment environment in which investment decisions are taken.
- Explain how to Value bonds and equities
- Explain the various approaches to value securities
- Describe how to create efficient portfolios through diversification
- Discuss the mechanism of investor protection in India.

PRE-REQUISITE: NIL

UNIT - I THE INVESTMENT ENVIRONMENT 9

The investment decision process, Types of Investments – Commodities, Real Estate and Financial Assets, the Indian securities market, the market participants and trading of securities, security market indices, sources of financial information, Concept of return and risk, Impact of Taxesand Inflation on return

UNIT – II FIXED INCOME SECURITIES 9

Bond features, types of bonds, estimating bond yields, Bond Valuation types of bond risks, default riskand credit rating.

UNIT – III APPROACHES TOEQUITYANALYSIS 9

Introduction to Fundamental Analysis, Technical Analysis and Efficient Market Hypothesis, dividend capitalisation models, and price-earnings multiple approach to equity valuation

UNIT – IV PORTFOLIO ANALYSIS AND FINANCIAL DERIVATIVES 9

Portfolio and Diversification, Portfolio Risk and Return; Mutual Funds; Introduction to Financial Derivatives; Financial Derivatives Markets in India

UNIT - V INVESTOR PROTECTION 9

Role of SEBI and stock exchanges in investor protection;Investor grievances and their redressal system, insider trading, investors' awareness and activism

TOTAL: 45 PERIODS

REFERENCES:

1. Charles P. Jones, Gerald R. Jensen. Investments: analysis and management. Wiley, 14TH Edition, 2019.
2. Chandra, Prasanna. Investment analysis and portfolio management. McGraw-hill education,5th, Edition, 2017.
3. Rustagi, R. P. Investment Management Theory and Practice. Sultan Chand & Sons, 2021.
4. ZviBodie, Alex Kane, Alan J Marcus, PitabusMohanty, Investments, McGraw Hill Education(India), 11 Edition(SIE), 2019

20MGV31	BANKING, FINANCIAL SERVICES AND INSURANCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Understand the Banking system in India
- Grasp how banks raise their sources and how they deploy it
- Understand the development in banking technology
- Understand the financial services in India
- Understand the insurance Industry in India

PRE-REQUISITE: NIL

UNIT - I INTRODUCTION TO INDIAN BANKING SYSTEM 9

Overview of Banking system – Structure – Functions –Banking system in India - Key Regulations inIndian Banking sector –RBI. Relationship between Banker and Customer - Retail & Wholesale Banking – types of Accounts - Opening and operation of Accounts.

UNIT – II MANAGING BANK FUNDS/ PRODUCTS 9

Liquid Assets - Investment in securities - Advances - Loans.Negotiable Instruments – Cheques, Bills of Exchange & Promissory Notes.Designing deposit schemes– Asset and Liability Management – NPA's – Current issues on NPA's – M&A's of banks into securities market

UNIT – III DEVELOPMENT IN BANKING TECHNOLOGY 9

Payment system in India – paper based – e payment –electronic banking –plastic money – e-money –forecasting of cash demand at ATM's –The Information Technology Act, 2000 in India – RBI's Financial Sector Technology vision document – security threats in e-banking & RBI's Initiative.

UNIT – IV FINANCIAL SERVICES 9

Introduction – Need for Financial Services – Financial Services Market in India – NBFC –– Leasing and Hire Purchase –– mutual funds. Venture Capital Financing –Bill discounting – factoring – Merchant Banking

UNIT - V INSURANCE 9

Insurance –Concept - Need - History of Insurance industry in India. Insurance Act, 1938 –IRDA – Regulations – Life Insurance - Annuities and Unit Linked Policies - Lapse of the Policy – revival – settlement of claim

TOTAL: 45 PERIODS

REFERENCES:

1. Padmalatha Suresh and Justin Paul, "Management of Banking and Financial Services, Pearson,Delhi, 2017.
2. Meera Sharma, "Management of Financial Institutions – with emphasis on Bank and RiskManagement", PHI Learning Pvt. Ltd., New Delhi 2010
3. Peter S. Rose and Sylvia C. and Hudgins, "Bank Management and Financial Services", TataMcGraw Hill, New Delhi, 2017

20MGV41	INTRODUCTION TO BLOCKCHAIN AND ITS APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basics of Blockchain
- To learn Different protocols and consensus algorithms in Blockchain
- To learn the fundamentals of Bitcoins and smart contracts
- To experiment the Hyperledger Fabric, Ethereum networks
- To understand the Blockchain Applications and trends

UNIT I INTRODUCTION TO BLOCKCHAIN 9

Blockchain: The growth of blockchain technology - Distributed systems - The history of blockchain and Bitcoin - Features of a blockchain - Types of blockchain, Consensus: Consensus mechanism - Types of consensus mechanisms - Consensus in blockchain. Decentralization: Decentralization using blockchain - Methods of decentralization - Routes to decentralization- Blockchain and full ecosystem decentralization - Smart contracts - Decentralized Organizations- Platforms for decentralization.

UNIT II INTRODUCTION TO CRYPTOCURRENCY 9

Bitcoin – Digital Keys and Addresses – Transactions – Mining – Bitcoin Networks and Payments – Wallets – Alternative Coins – Theoretical Limitations – Bitcoin limitations – Name coin – Prime coin – Zcash – Smart Contracts – Ricardian Contracts- Deploying smart contracts on a blockchain

UNIT III ETHEREUM 9

Introduction - The Ethereum network - Components of the Ethereum ecosystem - Transactions andmessages - Ether cryptocurrency / tokens (ETC and ETH) - The Ethereum Virtual Machine (EVM), Ethereum Development Environment: Test networks - Setting up a private net - Starting up the private network

UNIT IV WEB3 AND HYPERLEDGE 9

Introduction to Web3 – Contract Deployment – POST Requests – Development Frameworks – Hyperledger as a Protocol – The Reference Architecture – Hyperledger Fabric – Distributed Ledger– Corda.

UNIT V EMERGING TRENDS 9

Kadena – Ripple – Rootstock – Quorum – Tendermint – Scalability – Privacy – Other Challenges – Blockchain Research – Notable Projects – Miscellaneous Tools.

TOTAL: 45 PERIODS

REFERENCES:

1. Imran. Bashir. Mastering block chain: Distributed Ledger Technology, Decentralization, andSmart Contracts Explained. Packt Publishing, 2nd Edition, 2018
2. Peter Borovykh , Blockchain Application in Finance, Blockchain Driven, 2nd Edition, 2018
3. ArshdeepBahga, Vijay Madisetti, “Blockchain Applications: A Hands On Approach”, VPT,2017.

20MGV51	FINTECH PERSONAL FINANCE AND PAYMENTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand currency exchange and digital payments.
- To acquire the knowledge of Fintech firm and their role in Market
- To learn about InsurTech model and services
- To acquire knowledge about Fintech regulations and startups
- To understand P2P lending, challenges and solutions

UNIT I CURRENCY EXCHANGE AND PAYMENT 9

Understand the concept of Crypto currency- Bitcoin and Applications -Cryptocurrencies and Digital Crypto Wallets -Types of Cryptocurrencies - Cryptocurrencies and Applications, block chain, Artificial Intelligence, machine learning. Fintech users, Individual Payments, RTGS Systems, Immediate Page 54 of 90 Payment Service (IMPS), Unified Payments Interface (UPI).Legal and Regulatory Implications of Crypto currencies, Payment systems and their regulations. Digital Payments Smart Cards, Stored-Value Cards, EC Micropayments, Payment Gateways, Mobile Payments, Digital and Virtual Currencies, Security, Ethical, Legal, Privacy, and Technology Issues

UNIT II DIGITAL FINANCE AND ALTERNATIVE FINANCE 9

A Brief History of Financial Innovation, Digitization of Financial Services, Crowd funding, Charity andEquity,. Introduction to the concept of Initial Coin Offering

UNIT III INSURETECH 9

InsurTech Introduction , Business model disruption AI/ML in InsurTech - IoT and InsurTech ,Risk Modeling ,Fraud Detection Processing claims and Underwriting Innovations in Insurance Services

UNIT IV PEER TO PEER LENDING 9

P2P and Marketplace Lending, New Models and New Products in market place lending P2P Infrastructure and technologies , Concept of Crowdfunding Crowdfunding Architecture and Technology ,P2P and Crowdfunding unicorns and business models , SME/MSME Lending: Uniqueopportunities and Challenges, Solutions and Innovations

UNIT V REGULATORY ISSUES 9

FinTech Regulations: Global Regulations and Domestic Regulations, Evolution of RegTech, RegTech Ecosystem: Financial Institutions, RegTech Ecosystem: StartupsRegTech, Startups: Challenges, RegTech Ecosystem: Regulators, Use of AI in regulation and Fraud detection

TOTAL: 45 PERIODS

REFERENCES:

1. Swanson Seth, Fintech for Beginners: Understanding and Utilizing the power of technology,Createspace Independent Publishing Platform,2016.
2. Models AuTanda, Fintech Bigtech And Banks Digitalization and Its Impact On BankingBusiness, Springer, 2019
3. Henning Diedrich, Ethereum: Blockchains, Digital Assets, Smart Contracts, DecentralizedAutonomous Organizations, Wildfire Publishing, 2016
4. Jacob William, FinTech:TheBeginner's Guide to Financial Technology, CreatespaceIndependent Publishing Platform, 2016
5.IIBF, Digital Banking, Taxmann Publication, 2016
6.Jacob William, Financial Technology, Create space Independent Pub, 2016
7. Luke Sutton, Financial Technology: Bitcoin & Blockchain, Createspace Independent Pub,2016

20MGV61	INTRODUCTION TO FINTECH	L	T	P	C
		3	0	0	3

OBJECTIVES:

To learn about history, importance and evolution of Fintech
To acquire the knowledge of Fintech in payment industry
To acquire the knowledge of Fintech in insurance industry
To learn the Fintech developments around the world
To know about the future of Fintech

UNIT I INTRODUCTION 9

Fintech - Definition, History, concept, meaning, architecture, significance, Goals, key areas in Fintech, Importance of Fintech, role of Fintech in economic development, opportunities and challenges in Fintech, Evolution of Fintech in different sectors of the industry - Infrastructure, Banking Industry, Startups and Emerging Markets, recent developments in FinTech, future prospects and potential issues with Fintech.

UNIT II PAYMENT INDUSTRY 9

FinTech in Payment Industry-Multichannel digital wallets, applications supporting wallets, onboarding and KYC application, FinTech in Lending Industry- Formal lending, Informal lending, P2Plending, POS lending, Online lending, Payday lending, Microfinance, Crowdfunding.

UNIT III INSURANCE INDUSTRY 9

FinTech in Wealth Management Industry-Financial Advice, Automated investing, Socially responsible investing, Fractional Investing, Social Investing. FinTech in Insurance Industry- P2P insurance, On-Demand Insurance, On-Demand Consultation, Customer engagement through Quoteto sell, policy servicing, Claims Management, Investment linked health insurance.

UNIT IV FINTECH AROUND THE GLOBE 9

FinTech developments - US, Europe and UK, Germany, Sweden, France, China, India, Africa, Australia, New Zealand, Brazil and Middle East, Regulatory and Policy Assessment for Growth of FinTech. FinTech as disruptors, Financial institutions collaborating with FinTech companies, The new financial world.

UNIT V FUTURE OF FINTECH 9

How emerging technologies will change financial services, the future of financial services, banking on innovation through data, why FinTech banks will rule the world, The FinTech Supermarket, Bankspartnering with FinTech start-ups, The rise of BankTech, Fintech impact on Retail Banking, A futurewithout money, Ethics in Fintech.

TOTAL: 45 PERIODS

REFERENCES:

1) Arner D., Barbers J., Buckley R, The evolution of FinTech: a new post crisis paradigm,University of New South Wales Research Series, 2015
2) Susanne Chishti, Janos Barberis, The FINTECH Book: The Financial Technology Handbookfor Investors, Entrepreneurs and Visionaries, Wiley Publications, 2016
3) Richard Hayen, FinTech: The Impact and Influence of Financial Technology on Banking andthe Finance Industry, 2016
4) Parag Y Arjunwadkar, FinTech: The Technology Driving Disruption in the financial serviceindustry CRC Press, 2018
5) Sanjay Phadke, Fintech Future : The Digital DNA of Finance Paperback .Sage Publications,2020
6) Pranay Gupta, T. Mandy Tham, Fintech: The New DNA of Financial Services Paperback,2018

VERTICAL 2: ENTREPRENEURSHIP

		L	T	P	C
20MGV12	FOUNDATIONS OF ENTREPRENERUSHIP	3	0	0	3

OBJECTIVES:

To develop and strengthen the entrepreneurial quality and motivation of learners.
To impart the entrepreneurial skills and traits essential to become successful entrepreneurs.
To apply the principles and theories of entrepreneurship and management in Technology oriented business.
To empower the learners to run a Technology driven business efficiently and effectively

UNIT I INTRODUCTION TO ENTREPRENEURSHIP 9

Entrepreneurship- Definition, Need, Scope - Entrepreneurial Skill & Traits - Entrepreneur vs. Intrapreneur; Classification of entrepreneurs,Types of entrepreneurs - Factors affecting entrepreneurial development – Achievement Motivation – Contributions of Entreprenrship toEconomic Development

UNIT II BUSINESS OWNERSHIP & ENVRIONMENT 9

Types of Business Ownership – Buiness Envrionemental Factors – Political-Economic-Sociological-Technological-Environmental-Legal aspects – Human Reosurces Mobilisation-Basics of Managing Finance- Esentials of Marketing Management - Production and Operations Planning – Systems Management and Administration

UNIT III FUNDAMENTALS OF TECHNOPRENEURSHIP 9

Introduction to Technopreneurship - Definition, Need, Scope- Emerging Concepts- Principles - Characterisitcis of a technopreneur - Impacts of Technopreneurship on Society – Economy- Job Opportuinites in Technopreneurship - Recent trends

UNIT IV APPLICATIONS OF TECHNOPRENEURSHIP 9

Technology Entrepreneurship - Local, National and Global practices - Intrapreneurship and Technology interactions, Networking of entrepreneurial activities – Launching - Managing Technology based Product / Service entrepreneurship -– Success Stories of Technopreneurs - CaseStudies

UNIT V EMERGING TRENDS IN ENTREPRENERUSHIP 9

Effective Business Management Strategies For Franchising - Sub-Contracting- Leasing- Technopreneurs – Agripreneurs - Netpreneurs- Portfolio entrepreneruship - NGO Entrepreneurship

TOTAL: 45 PERIODS

TEXT BOOKS:

1 S.S.Khanka, “Entrepreneurial Development” S.Chand & Co. Ltd. Ram Nagar New Delhi, 2021.
2 Donal F Kuratko Entrepreneurship (11th Edition) Theory, Process, Practice by Published 2019 by Cengage Learning

REFERENCES:

1 Daniel Mankani. 2003. Technopreneurship: The successful Entrepreneur in the new Economy. Prentice Hall

2 Edward Elgar. 2007. Entrepreneurship, Cooperation and the Firm: The Emergence and Survivalof High-Technology Ventures in Europe. Edi: Jan Ulijn, Dominique Drillon, and Frank Lasch. Wiley

3 Lang, J. 2002, The High Tech Entrepreneur's Handbook, Ft.com.

4 David Sheff 2002, China Dawn: The Story of a Technology and Business Revolution,

5 Harper Business https://fanny.staff.uns.ac.id/files/2013/12/Technopreneur-BASED-EDUCATION-REVOLUTION.pdf

6 JumpStart: A Technoprenuership Fable, Dennis Posadas, (Singapore: Pearson Prentice Hall,2009

7 Basics of Technoprenuership: Module 1.1-1.2, Frederico Gonzales, President-PESO Inc; M.Barcelon, UP

8 Journal articles pertaining to Entrepreneurship

20MGV22	TEAM BUILDING & LEADERSHIP MANAGEMENT FOR BUSINESS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To develop and strengthen the Leadership qualities and motivation of learners.
To impart the Leadership skills and traits essential to become successful entrepreneurs.
To apply the principles and theories of Team Building in managing Technology oriented business.
To empower the learners to build robust teams for running and leading a business efficientlyand effectively

UNIT I INTRODUCTION TO MANAGING TEAMS 9

Introduction to Team - Team Dynamics - Team Formation – Stages of Team Devlopment - Enhancing teamwork within a group - Team Coaching - Team Decision Making - Virtual Teams - SelfDirected Work Teams (SDWTs) -Multicultural Teams.

UNIT II MANAGING AND DEVELOPING EFFECTIVE TEAMS 9

Team-based Organisations- Leadershp roles in team-based organisations - Offsite training and team development - Experiential Learning - Coaching and Mentoring in team building - Building High-Performance Teams - Building Credibility and Trust - Skills for Developing Others - Team Building at the Top - Leadership in Teamwork Effectiveness.

UNIT III INTRODUCTION TO LEADERSHIP 9

Introduction to Leadership - Leadership Myths – Characteristics of Leader, Follower and Situation -Leadership Attributes - Personality Traits and Leadership- Intelligence Types and Leadership - Power and Leadership - Delegation and Empowerment.

UNIT IV LEADERSHIP IN ORGANISATIONS 9

Leadership Styles – LMX Theory- Leadership Theory and Normative Decision Model - Situational Leadership Model - Contingency Model and Path Goal Theory – Transactional and Transformational Leadership - Charismatic Leadership - Role of Ethics and Values in

UNIT V LEADERSHIP EFFECTIVENESS 9

Leadership Behaviour - Assessment of Leadership Behaviors - Destructive Leadership - Motivation and Leadership - Managerial Incompetence and Derailment Conflict Management - Negotiation and Leadership - Culture and Leadership - Global Leadership – Recent Trends in

TOTAL: 45 PERIODS

REFERENCES:

1. Hughes, R.L., Ginnett, R.C., & Curphy, G.J., Leadership: Enhancing the lessons of experience ,9th Ed, McGraw Hill Education, Chennai, India. (2019).
2. Katzenback, J.R., Smith, D.K., The Wisdom of Teams: Creating the HighPerformance Organisations, Harvard Business Review Press, (2015).
3. Haldar,U.K., Leadership and Team Building, Oxford University Press, (2010).
4. Daft, R.L., The Leadership Experience, Cengage, (2015).
5. Daniel Levi, Group Dynamics for Teams ,4th Ed, (2014), Sage Publications.
6. Dyer, W. G., Dyer, W. G., Jr., & Dyer, J. H..Team building: Proven strategies for improvingteam performance, 5thed, Jossey-Bass, (2013).

20MGV32	CREATIVITY & INNOVATION IN ENTREPRENEURSHIP	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To develop the creativity skills among the learners
- To impart the knowledge of creative intelligence essential for entrepreneurs
- To know the applications of innovation in entprerenship.
- To develop innovative business models for business.

UNIT I CREATIVITY 9

Creativity: Definition- Forms of Creativity-Essence, Elaborative and Expressive Creativities-Quality of Creativity-Existential, Entrepreneurial and Empowerment Creativities – Creative Environment- Creative Technology- - Creative Personality and Motivation.

UNIT II CREATIVE INTELLIGENCE 9

Creative Intelligence: Convergent thinking ability – Traits Congenial to creativity – Creativity Training- -Criteria for evaluating Creativity-Credible Evaluation- Improving the quality of our creativity – Creative Tools and Techniques - Blocks to creativity- fears and Disabilities- Strategies for Unblocking- Designing Creativity Enabling Environment.

UNIT III INNOVATION 9

Innovation: Definition- Levels of Innovation- Incremental Vs Radical Innovation-Product Innovation and Process- Technological, Organizational Innovation – Indicators- Characteristics of Innovation in Different Sectors. Theories in Innovation and Creativity- Design Thinking and Innovation- Innovationas Collective Change-Innovation as a system

UNIT IV INNOVATION AND ENTREPRENEURSHIP 9

Innovation and Entrepreneurship: Entrepreneurial Mindset , Motivations and Behaviours-Opportunity Analysis and Decision Making- Industry Understanding - Entrepreneurial Opportunities-Entrepreneurial Strategies – Technology Pull/Market Push – Product -Market fit

UNIT V INNOVATIVE BUSINESS MODELS 9

Innovative Business Models: Customer Discovery-Customer Segments-Prospect Theory and Developing Value Propositions- Developing Business Models: Elements of Business Models – Innovative Business Models: Elements, Designing Innovative Business Models-ResponsibleInnovation and Creativity.

TOTAL: 45 PERIODS

REFERENCES:

1. Creativity and Inovation in Entrepreneurship, Kankha, Sultan Chand
2. Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata Mc Graw Hill, 2004.Paul Trott, Innovation Management and New Product Development, 4e, Pearson, 2018.
3. Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014. Innovation Management, C.S.G. Krishnamacharyulu, R. Lalitha, Himalaya Publishing House, 2010.
4. A.Dale Timpe, Creativity, Jaico Publishing House, 2003.Brian Clegg, Paul Birch, Creativity, Kogan Page, 2009.
5. Strategic Innovation: Building and Sustaining Innovative Organizations- Course Era, Raj Echambadi.

20MGV42	PRINCIPLES OF MARKETING MANAGEMENT FOR BUSINESS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide basic knowledge of concepts, principles, tools and techniques of marketing forentrepreneurs
- To provide an exposure to the students pertaining to the nature and Scope of marketing,which they are expected to possess when they enter the industry as practitioners.
- To give them an understanding of fundamental premise underlying market driven strategiesand the basic philosophies and tools of marketing management for business owners.

UNIT I INTRODUCTION TO MARKETING MANAGEMENT 9

Introduction - Market and Marketing – Concepts- Functions of Marketing - Importance of Marketing Marketing Orientations - Marketing Mix-The Traditional 4Ps - The Modern Components of the Mix -The Additional 3Ps - Developing an Effective Marketing Mix.

UNIT II MARKETING ENVIRONMENT 9

Introduction - Environmental Scanning - Analysing the Organisation's Micro Environment and Macro Environment - Differences between Micro and Macro Environment – Techniques of Environment Scanning - Marketing organization - Marketing Research and the Marketing Information System, Types and Components.

UNIT III PRODUCT AND PRICING MANAGEMENT 9

Product- Meaning, Classification, Levels of Products – Product Life Cycle (PLC) - Product Strategies - Product Mix - Packaging and Labelling - New Product Development - Brand and Branding - Advantages and disadvantages of branding Pricing - Factors Affecting Price Decisions - Cost Based Pricing - Value Based and Competition Based Pricing - Pricing Strategies - National and Global Pricing.

UNIT IV PROMOTION AND DISTRIBTUION MANAGEMENT 9

Introduction to Promotion – Marketing Channels- Integrated Marketing Communications (IMC) - Introduction to Advertising and Sales Promotion – Basics of Public Relations and Publicity - PersonalSelling - Process - Direct Marketing - Segmentation, Targeting and Positioning (STP)- Logistics Management- Introduction to Retailing and Wholesaling.

UNIT V CONTEMPORARY ISSUES IN MARKETING MANAGEMENT 9

Introduction - Relationship Marketing Vs. Relationship Management - Customer Relationship Management (CRM) - Forms of Relationship Management - CRM practices - Managing Customer Loyalty and Development – Buyer-Seller Relationships- Buying Situations in Industrial / Business Market - Buying Roles in Industrial Marketing - Factors that Influence Business - Services Marketing E-Marketing or Online Marketing.

TOTAL: 45 PERIODS

REFERENCES

1. Marketing Management, Sherlekar S.A, Himalaya Publishing House, 2016.
2. Marketing Management , Philip Kortler and Kevin Lane Keller, PHI 15th Ed, 2015.
3 Marketing Management- An Indian perspective, Vijay Prakash Anand, Biztantra, Second edition,2016.
4. Marketing Management Global Perspective, Indian Context, V.S.Ramaswamy &

S.Namakumari, Macmillan Publishers India,5th edition, 2015.
5. Marketing Management, S.H.H. Kazmi, 2013, Excel Books India.
6. Marketing Management- text and Cases, Dr. C.B.Gupta & Dr. N.Rajan Nair, 17th edition, 2016.

20MGV52	HUMAN RESOURCE MANAGEMENT FOR ENTREPRENEURS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the basic concepts, structure and functions of human resource management for entrepreneurs.
- To create an awareness of the roles, functions and functioning of human resource department.
- To understand the methods and techniques followed by Human Resource Management practitioners.

UNIT I INTRODUCTION TO HRM 9

Concept, Definition, Objectives- Nature and Scope of HRM - Evolution of HRM - HR Manager Roles-Skills - Personnel Management Vs. HRM - Human Resource Policies - HR Accounting - HR Audit -Challenges in HRM.

UNIT II HUMAN RESOURCE PLANNING 9

HR Planning - Definition - Factors- Tools - Methods and Techniques - Job analysis- Job rotation- Job Description - Career Planning - Succession Planning - HRIS - Computer Applications in HR - Recent Trends.

UNIT III RECRUITMENT AND SELECTION 9

Sources of recruitment- Internal Vs. External - Domestic Vs. Global Sources -eRecruitment - Selection Process- Selection techniques -eSelection- Interview Types- Employee Engagement

UNIT IV TRAINING AND EMPLOYEE DEVELOPMENT 9

Types of Training - On-The-Job, Off-The-Job - Training Needs Analysis – Induction and Socialisation Process - Employee Compensation - Wages and Salary Administration – Health and Social SecurityMeasures- Green HRM Practices

UNIT V CONTROLLING HUMAN RESOURCES 9

Performance Appraisal – Types - Methods - Collective Bargaining - Grievances Redressal Methods – Employee Discipline – Promotion – Demotion - Transfer – Dismissal - Retrenchment - Union Management Relationship - Recent Trends

TOTAL: 45 PERIODS

REFERENCES:

1) Gary Dessler and Biju Varkkey, Human Resource Management, 14e , Pearson, 2015.
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5) Luis R.Gomez-Mejia, David B.Balkin, Robert L Cardy. Managing Human Resource. PHILearning. 2012
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20MGV62	FINANCING NEW BUSINESS VENTURES	L	T	P	C
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OBJECTIVES:

- To develop the basics of business venture financing.
- To impart the knowledge essential for entrepreneurs for financing new ventures.
- To acquaint the learners with the sources of debt and quity financing.
- To empower the learners towards fund rasiing for new ventures effectively.

UNIT I ESSENTIALS OF NEW BUSINES VENTURE 9

Setting up new Business Ventures – Need - Scope - Franchising - Location Strategy, Registration Process - State Directorate of Industries- Financing for New Ventures - Central and State Government Agencies - Types of loans – Financial Institutions - SFC, IDBI, NSIC and SIDCO.

UNIT II INTRODUCTION TO VENTURE FINANCING 9

Venture Finance – Definition – Historic Background - Funding New Ventures- Need – Scope – Types - Cost of Project - Means of Financing - Estimation of Working Capital - Requirement of funds – Mixof Dent and Equity - Challenges and Opportunities.

UNIT III SOURCES OF DEBT FINANCING 9

Fund for Capital Assets - Term Loans - Leasing and Hire-Purchase - Money Market instruments – Bonds, Corporate Papers – Preference Capital- Working Capital Management- Fund based Credit Facilities - Cash Credit - Over Draft.

UNIT IV SOURCES OF EQUITY FINANCING 9

Own Capital, Unsecured Loan - Government Subsidies , Margin Money- Equity Funding - Private Equity Fund- Schemes of Commercial banks - Angel Funding – Crowdfunding- Venture Capital.

UNIT V METHODS OF FUND RAISING FOR NEW VENTURES 9

Investor Decision Process - Identifying the appropriate investors- Targeting investors- Developing Relationships with investors - Investor Selection Criteria- Company Creation- Raising Funds - SeedFunding- VC Selection Criteria – Process- Methods- Recent Trends

TOTAL: 45 PERIODS

REFERENCES:

1. Principles of Corporate Finance by Brealey and Myers et al.,12TH ed, McGraw Hill Education(India) Private Limited, 2018
2. Prasanna Chandra, Projects : Planning ,Analysis, Selection,Financing, Implementation and Review, McGraw Hill Education India Pvt Ltd ,New Delhi , 2019.
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4. Metrick, Andrew; Yasuda, Ayako. Venture Capital And The Finance Of Innovation. Venture Capital And The Finance Of Innovation, 2nd Edition, Andrew Metrick And Ayako Yasuda, Eds., JohnWiley And Sons, Inc, 2010.
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6. May, John; Simons, Cal. Every Business Needs An Angel: Getting The Money You Need ToMake Your Business Grow. Crown Business, 2001.
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