NATIONAL ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University Chennai & Accredited by NAAC)

K.R.NAGAR, KOVILPATTI – 628 503
www.nec.edu.in

REGULATIONS – 2019

CURRICULUM & SYLLABUS

B. E. – ELECTRICAL AND ELECTRONICS ENGINEERING

Accredited by NBA

B. E. – ELECTRICAL AND ELECTRONICS ENGINEERING

CURRICULUM AND SYLLABUS

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION

Promoting active learning, critical thinking coupled with ethical values to meet the global challenges.

MISSION

- To instill state-of-the-art technical knowledge and research capability that will prepare our graduates for professionalism and life-long learning.
- To update knowledge to meet industrial and real world challenges.
- To inculcate social and ethical values.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Excel in industrial or graduate work in Electrical Engineering and allied fields.
2. Practice their profession conforming to ethical values and active participation in the affairs of the profession.
3. Adapt to evolving technologies and stay current with their profession.

PROGRAMME OUTCOMES (POs)

Pos *describe the expectation of students to know by the time of graduation from the programme*. At the time of graduation, our EEE graduates are expected to:

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

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

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

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Apply the basic knowledge of mathematics, science and engineering to identify, formulate, design and investigate complex engineering problems of power electronics and drives, power and energy systems, high voltage engineering, control and instrumentation and applied electronics.

PSO2: Apply the modern engineering hardware and software tools in electrical and electronics engineering to adopt in multi disciplinary environments and innovative practices.

PREAMBLE OF THE CURRICULUM & SYLLABI

The Curriculum and Syllabi under Regulations 2019 are implemented based on the recommendations of AICTE, New Delhi and UGC, New Delhi. The course content of each course shall be fixed in accordance with the Programme Educational Objectives (PEOs), Programme Outcomes (POs) and Course Outcomes (COs).

Further, The CBCS enables the students to earn credits across programmes and provides flexibility for slow and fast learners in registering the required number of credits in a semester. The CBCS facilitates the transfer of credits earned in different departments / Centers of other recognized / accredited universities or institutions of higher education in India and abroad either by studying directly or by online method.

The curriculum of **EEE programme** is designed with total number of credits ***167 (127*** for Lateral entry). The curriculum shall have the following category of courses with credits as given in Table-1.

TABLE – 1 CATEGORY OF COURSES

Sl. No	Coursework – Subject Area	The range of Total credits
1.	Humanities and Social Sciences including Management courses	10
2.	Basic Science courses	29
3.	Engineering Science courses	22
4.	Programme Core courses	64
5.	Programme Elective courses relevant to chosen specialization / branch	15
6.	Open Elective courses from other technical and /or emerging subject areas	12
7.	Skill Development Courses	15
8.	Mandatory courses	(non – credit)
	TOTAL	**167**

i. **Humanities and Social Sciences (HSMC)** include English, Communication Skill laboratory and Management courses

ii. **Basic Science Courses (BSC)** include Chemistry, Physics, Biology and Mathematics

iii. **Engineering Science Courses (ESC)** include Workshop, Drawing, Basics of Electrical / Electronics / Mechanical / Civil / Computer / Instrumentation Engineering

iv. **Programme Core Courses (PCC)** include the core courses relevant to the chosen programme of study.

v. **Programme Elective Courses (PEC)** include the elective courses relevant to the chosen programme of study.

vi. **Open Elective Courses (OEC)** include inter-disciplinary courses which are offered in other Engineering/Technology Programme of study.

vii. **Skill Development Courses (SDC)** include the courses such as Project, Seminar and Inplant training / Internship for improving Employability Skills.

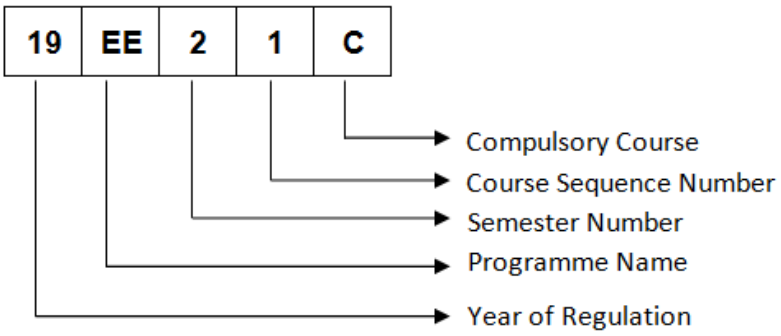
viii. **Mandatory courses (MAC)** include Personality and Character development and the courses recommended by the regulatory bodies such as AICTE, UGC, etc.

Performance in each course of study shall be evaluated based on Continuous Assessment throughout the semester and end semester examination at the end of the programme. Keeping in mind the content of the courses and delivery methods, different question paper patterns are suggested, as given in Table-2.

TABLE – 2 QP – QUESTION PATTERN

Subject Type	Question pattern	2 marks	4 marks	10 marks	11 marks	12 marks	20 marks	Total
Theory (3/4 Credit)	A	10	5	--	--	1 Qn Compulsory & 4 Qns (either or type)	--	100
Theory (2 Credit)	B	10	-	-	1 Qn Compulsory & 4Qn (either or type)			75
Theory (1 Credit)	C	5	--	1 Qn Compulsory & 1 Qn (either or type)	--	--	--	30
Theory Trans Disciplinary	D	--	--	--	--	--	5 out of 8	100
Design oriented	E	--	--	--	--	--	1 Qn Compulsory & 4 Qns (either or type)	100
10,11 and 12 marks questions will be a single question and no subdivisions								

FORMAT FOR COURSE CODE



REGULATIONS – 2019 CURRICULUM AND SYLLABUS

SEMESTER – I

S. No	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1.	HSMC	19SH11C	Technical English	2	0	0	2	B
2.	BSC	19SH12C	Mathematical Foundations For Engineers	3	1	0	4	A
3.	BSC	19SH13C	Engineering Physics	2	0	0	2	B
4.	BSC	19SH14C	Engineering Chemistry	2	0	0	2	B
5.	ESC	19SH15C	Engineering Graphics	2	0	4	4	E
PRACTICAL COURSES								
6.	BSC	19SH16C	Engineering Physics and Engineering Chemistry Laboratory Part A – Engineering Physics Laboratory Part B – Engineering Chemistry Laboratory	0	0	3	1.5	
7.	ESC	19SH17C	Engineering Practice Laboratory* Part A – Mechanical Laboratory Part B – Electrical and Electronics Laboratory	0	0	4	2	
			TOTAL	**11**	**1**	**11**	**17.5**	

SEMESTER – II

S. No	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1	HSMC	19EE21C	Professional English	2	0	0	2	B
2	BSC	19EE22C	Calculus, Probability and Statistics	2	1	0	3	A
3	BSC	19EE23C	Waves, Optics and Semiconductor Physics	2	0	0	2	B
4	BSC	19EE24C	Chemistry for Electrical Engineering	2	0	0	2	B
5	ESC	19EE25C	Problem Solving Techniques	3	0	0	3	A
6	ESC	19EE26C	Basic Civil and Mechanical Engineering	4	0	0	4	A
PRACTICAL COURSES								
7.	BSC	19EE27C	Optics and Semiconductor Physics and Chemistry Laboratory Part A – Optics and Semiconductor Physics Laboratory Part B – Chemistry Laboratory	0	0	3	1.5	-
8.	ESC	19EE28C	Problem Solving Techniques Laboratory	0	0	4	2	-
9.	HSMC	19EE29C	Communication Skills Laboratory	0	0	2	1	-
10.	SDC	19GN01C	Innovation through Design Thinking	1	0	2	2	
			TOTAL	**16**	**1**	**11**	**22.5**	

SEMESTER – III

S. No	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1.	BSC	19EE31C	Fourier Series and Transforms	2	1	0	3	A
2.	PCC	19EE32C	Electrical Circuit Analysis	3	1	0	4	A
3.	PCC	19EE33C	Analog Electronics	3	1	0	4	A
4.	PCC	19EE34C	Electrical Machines-I	3	0	0	3	A
5.	PCC	19EE35C	Electromagnetic Fields	3	1	0	4	A
6.	ESC	19EE36C	Engineering Mechanics	3	0	0	3	A
7.	MAC	19MC01C	Environmental Science and Engineering	3	0	0	0	D
PRACTICAL COURSES								
8.	PCC	19EE37C	Analog Electronics Laboratory	0	0	3	1.5	-
9.	PCC	19EE38C	Electrical Machines-I Laboratory	0	0	3	1.5	-
			TOTAL	**20**	**4**	**6**	**24**	

SEMESTER – IV

S. No	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1.	BSC	19EE41C	Complex Analysis, Numerical Methods and Mathematical Logic	2	1	0	3	A
2.	PCC	19EE42C	Digital Electronics	3	0	0	3	A
3.	PCC	19EE43C	Electrical machines-II	3	0	0	3	A
4.	PCC	19EE44C	Measurements and Instrumentation	3	0	0	3	A
5.	PCC	19EE45C	Signals and systems	2	1	0	3	A
6.	BSC	19EE46C	Biology for Engineers	2	0	0	2	B
7.	MAC	19MC02C	Constitution of India	3	0	0	0	D
PRACTICAL COURSES								
8.	PCC	19EE47C	Digital Electronics laboratory	0	0	3	1.5	-
9.	PCC	19EE48C	Measurements and Instrumentation Laboratory	0	0	3	1.5	-
10.	PCC	19EE49C	Electrical machines-II laboratory	0	0	3	1.5	-
			TOTAL	**18**	**2**	**9**	**21.5**	

SEMESTER – V

S. No	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1.	PCC	19EE51C	Power System-I	3	0	0	3	A
2.	PCC	19EE52C	Control Systems	3	0	0	3	A
3.	PCC	19EE53C	Microprocessor and Microcontroller	3	0	0	3	A
4.	PCC	19EE54C	High Voltage Engineering	3	0	0	3	A
5.	PEC	-	Program Elective-1	3	0	0	3	
6.	ESC	19EE55C	Object Oriented Programming	3	0	2	4	A
PRACTICAL COURSES								
7.	PCC	19EE56C	Control Systems Laboratory	0	0	3	1.5	-
8.	PCC	19EE57C	Microprocessor and Microcontroller Laboratory	0	0	3	1.5	-
			TOTAL	**18**	**0**	**8**	**22**	

SEMESTER – VI

S. No	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1.	PCC	19EE61C	Power System-II	3	0	0	3	A
2.	PCC	19EE62C	Power Electronics	3	0	0	3	A
3.	PCC	19EE63C	Switchgear and Protection	3	0	0	3	A
4.	PEC	-	Program Elective-2	3	0	0	3	-
5.	OEC	-	OE-1	3	0	0	3	-
PRACTICAL COURSES								
6.	PCC	19EE64C	Power System simulation and High voltage Laboratory	0	0	2	1	-
7.	PCC	19EE65C	Power Electronics laboratory	0	0	3	1.5	-
8.	PCC	19EE66C	Electronics Design Laboratory	1	0	4	3	-
9.	SDC	19EE67C	Product Development Laboratory	1	0	2	2	-
			TOTAL	**17**	**0**	**11**	**22.5**	

SEMESTER – VII

S. No	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1.	PEC	-	Program Elective-3	3	0	0	3	-
2.	PEC	-	Program Elective-4	3	0	0	3	-
3.	OEC	-	OE-2	3	0	0	3	-
4.	OEC		OE-3	3	0	0	3	-
5.	OEC	-	OE-4	3	0	0	3	-
6.	HSMC	19EE71C	Project Management and Finance	3	0	0	3	-
PRACTICAL COURSES								
7.	SDC	19EE72C	Project Work – I	0	0	6	3	-
8.	SDC	19EE73C	Research Paper and Patent Review – Seminar	0	0	2	1	-
9.	PCC	19EE74C	Comprehension	0	0	2	1	-
			TOTAL	**18**	**-**	**10**	**23**	

SEMESTER – VIII

S. No	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1.	PEC	-	Program Elective-5	3	0	0	3	-
2.	HSMC	-	Elective Slot For HS (Social sciences-self study)	0	0	0	3	-
PRACTICAL COURSES								
3.	SDC	19EE81C	Internship / In-plant Training	0	0	4	2	-
4.	SDC	19EE82C	Project Work – II	0	0	12	6	-
			TOTAL	**3**	**-**	**16**	**14**	

OVER ALL CREDITS: 167

PROGRAMME ELECTIVE COURSES

S. No	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
1.	PEC	19EE01E	Electrical Machine Design	3	0	0	3	A
2.	PEC	19EE02E	Electrical Drives	3	0	0	3	A
3.	PEC	19EE03E	Industrial Electrical Systems	3	0	0	3	A
4.	PEC	19EE07E	Switched Mode Power Conversions	3	0	0	3	A
5.	PEC	19EE08E	Special Electrical Machines	3	0	0	3	A
6.	PEC	19EE10E	Power Electronics for Renewable Energy Systems	3	0	0	3	A
7.	PEC	19EE14E	Power System Transients	3	0	0	3	A
8.	PEC	19EE15E	Wind and Solar Energy Systems	3	0	0	3	A
9.	PEC	19EE16E	Power Quality	3	0	0	3	A
10.	PEC	19EE18E	Power System Dynamics and Control	3	0	0	3	A
11.	PEC	19EE19E	Electrical Energy Conservation and Auditing	3	0	0	3	A
12.	PEC	19EE22E	Solar Photovoltaic Systems	3	0	0	3	A
13.	PEC	19EE24E	Smart Grid	3	0	0	3	A
14.	PEC	19EE25E	Power Generation Systems	3	0	0	3	A
15.	PEC	19EE26E	Electrical Safety	3	0	0	3	A
16.	PEC	19EE28E	CAD of Electrical Apparatus	3	0	0	3	A
17.	PEC	19EE30E	Insulation Technology	3	0	0	3	A
18.	PEC	19EE31E	EHV Power Transmission	3	0	0	3	A
19.	PEC	19EE32E	HVDC Transmission Systems	3	0	0	3	A
20.	PEC	19EE34E	Digital Control Systems	3	0	0	3	A
21.	PEC	19EE35E	Control Systems Design	3	0	0	3	A
22.	PEC	19EE37E	Logic and Distributed Control System	3	0	0	3	A
23.	PEC	19EE38E	Biomedical Instrumentation	3	0	0	3	A
24.	PEC	19EE39E	Advanced Control Theory	3	0	0	3	A
25.	PEC	19EE40E	Soft Computing for Electrical Engineering	3	0	0	3	A
26.	PEC	19EE41E	Digital Signal Processing	3	0	0	3	A
27.	PEC	19EE42E	Robotics and Automation	3	0	0	3	A
28.	PEC	19EE44E	Embedded Systems	3	0	0	3	A
29.	PEC	19EE45E	MEMS and NEMS	3	0	0	3	A
30.	PEC	19EE46E	VLSI Design	3	0	0	3	A
31.	PEC	19EE47E	DSP based System Design	3	0	0	3	A
32.	PEC	19EE48E	Microcontroller based System Design	3	0	0	3	A
33.	PEC	19EE50E	Advanced Microprocessor and Microcontroller	3	0	0	3	A
34.	PEC	19EE52E	Real Time Operating Systems	3	0	0	3	A
35.	PEC	19EE53E	Automotive Electrical and Electronics	3	0	0	3	A
36.	PEC	19EE54E	Mobile Robots and Control	3	0	0	3	A
37.	PEC	19EE55E	Electric Vehicle Machines and Drives	3	0	0	3	A
38.	PEC	19EE56E	Battery Management systems and Modeling	3	0	0	3	A
39.	PEC	19EE57E	Control of Hybrid Electric Vehicles	3	0	0	3	A

40.	PEC	19EE58E	Autonomous Intelligent Vehicles	3	0	0	3	A
41.	PEC	19EE59E	Electronics Design and Technology	3	0	0	3	A

ONE CREDIT ELECTIVE COURSES

S. No	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
1.	OEC	19EE01L	Design of Power Converters Laboratory	0	0	2	1	-
2.	OEC	19EE02L	Energy storage system	1	0	0	1	C
3.	OEC	19EE03L	LVDC wiring	1	0	0	1	C
4.	OEC	19EE04L	Digital substation	1	0	0	1	C
5.	OEC	19EE05L	Electrical system for smart building	1	0	0	1	C
6.	OEC	19EE06L	Power System Protection and Substation Automation	1	0	0	1	C
7.	OEC	19EE07L	Energy Laboratory	0	0	2	1	-
8.	OEC	19EE08L	HVDC circuit breakers	1	0	0	1	C
9.	OEC	19EE09L	Earthing design	1	0	0	1	C
10.	OEC	19EE10L	Alternate insulating medium	1	0	0	1	C
11.	OEC	19EE11L	Communication technologies for smart grids	1	0	0	1	C
12.	OEC	19EE12L	Non-Conventional instrument Transformer	1	0	0	1	C
13.	OEC	19EE13L	Industrial Controllers Laboratory	0	0	2	1	-
14.	OEC	19EE14L	Soft Computing for Electrical Engineering Laboratory	0	0	2	1	-
15.	OEC	19EE15L	Electronics for safety critical system	1	0	0	1	C
16.	OEC	19EE16L	PCB design and fabrication	0	0	2	1	-
17.	OEC	19EE17L	Embedded System Laboratory	0	0	2	1	-
18.	OEC	19EE18L	Techno commercial project proposal	1	0	0	1	C
19.	OEC	19EE19L	Virtual Instrumentation	1	0	0	1	C
20.	OEC	19EE20L	Electrical Power Capacitors	1	0	0	1	C
21.	OEC	19EE21L	Internet of Things and Embedded Systems	1	0	0	1	C
22.	OEC	19EE22L	High Voltage Testing Techniques	0	0	2	1	-
23.	OEC	19EE23L	Quality practices for safety critical instrumentation system	1	0	0	1	C
24.	OEC	19EE24L	Switchgear and Protection Laboratory	0	0	2	1	-
25.	OEC	19EE25L	Electric vehicles simulation Laboratory	0	0	2	1	-
26.	OEC	19EE26L	EV Battery Design and Modeling Laboratory	0	0	2	1	-
27.	OEC	19EE27L	Python Programming in Raspberry Pi and Hardware Interfacing	0	0	2	1	-
28.	OEC	19EE28L	Arduino Programming	0	0	2	1	-
29.	OEC	19EE29L	Hydrogen Energy and Fuel Cells	1	0	0	1	C

TRANS-DISCIPLINARY ELECTIVE COURSES – SELF STUDY

S. No	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
1.	OEC	19TD05E	Indian Economy	0	0	0	3	D
2.	OEC	19TD09E	Indian History	0	0	0	3	D
3.	OEC	19TD10E	Sustainable Development and Practices	0	0	0	3	D
4.	OEC	19TD11E	Women in Indian Society	0	0	0	3	D
5.	OEC	19TD13E	Leadership and Personality Development	0	0	0	3	D

19SH11C **TECHNICAL ENGLISH** **L T P C**

(Common to all B.E. / B.Tech. Degree Programmes) **2 0 0 2**

COURSE OUTCOMES

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

CO1: apply the basic language skills to understand various aspects of communication skills (K3)

CO2: express their thoughts with correct usage of language in formal writings (K3)

CO3: understand various language components and develop the pronunciation skill. (K2)

CO4: make effective technical writings and interpret any pictorial representation. (K3)

CO5: frame sentences and write effective reports. (K3)

UNIT I **6**

Parts of Speech – Word formation using Prefixes and Suffixes - Informal writing - Diary writing, Letter to Friend / Parent / Siblings - Greetings and Self Introduction – Situational Phrases - Tense (Present)

UNIT II **6**

Technical terms and extended definitions - Transformation of words into different grammatical forms – Tense (Past) – Letter writing (for Industrial visit and training) - Instruction Writing - Listening for general information.

UNIT III **6**

Personality Adjectives - Phonetics (Vowels - Consonants– Diphthongs - Transcriptions) – Kinds of Sentences (Statement, Interrogative, Imperative & Exclamatory) – Situational Conversation.

UNIT IV **6**

Commonly Misspelled words – Active and Passive Voices – E - mail writing - Picture Description – Checklists

UNIT V **6**

Homophones - Concord - Tense (Future) - Foreign Words and Phrases - Report writing (Types – Structure - Stages in Report writing- Model Report) – Reading Comprehension.

Suggested Activity: Book Review – Herein the students will be required to submit a review of a book (Literary or non-literary) of their choice. This will be followed by a presentation of the same in the class.

L: 30; TOTAL: 30 PERIODS

TEXT BOOKS

1. Anderson, Paul V. “Technical Communication: A Reader - Centered Approach”, 9th Edition, Cengage, New Delhi, 2018.
2. Jan Svartvik, et.al. “A Comprehensive Grammar of the English Language”, Longman Inc., Newyork, 2014.

REFERENCES

1. Murphy Raymond, “Basic Grammar Practice on Tense”, Cambridge University Press: New Delhi, 2018.
2. Kumar, Suresh. E., “Engineering English”, Orient Blackswan: Hyderabad, 2015.

19SH12C MATHEMATICAL FOUNDATIONS FOR ENGINEERS L T P C
(Common to all B.E. / B.Tech. Degree Programmes) 3 1 0 4

COURSE OUTCOMES

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

CO1: make use of orthogonal transformation. (K3)
CO2: find the evolutes of various curves.(K2)
CO3: maxima and minima of real valued functions.(K3)
CO4: solve ordinary differential equations.(K2)
CO5: solve partial differential equations.(K2)

UNIT I MATRICES 12

Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values and Eigen vectors – Diagonalisation of a matrix by orthogonal transformation – Quadratic forms – Reduction of quadratic form to canonical form by orthogonal transformation and its nature; Cayley – Hamilton theorem (excluding proof)

UNIT II DIFFERENTIAL CALCULUS 12

Curvature in cartesian, parametric and polar forms – Centre of curvature, radius of curvature and circle of curvature – Evolutes – Envelopes – Evolute as envelope of normals.

UNIT III FUNCTIONS OF SEVERAL VARIABLES 12

Partial derivative – Total derivative – Euler’s theorem on homogeneous functions – Taylor’s Series – Jacobians – Maxima and Minima – Constrained Maxima and Minima by the method of Lagrange’s multipliers.

UNIT IV ORDINARY DIFFERENTIAL EQUATIONS 12

Solutions of first order ordinary differential equations - Equations solvable for ‘p’, equations solvable for ‘y’, equations solvable for ‘x’ - Solutions of higher order linear differential equations with constant coefficients – Cauchy’s and Legendre’s linear equations - Method of variation of parameters – Solution of simultaneous linear differential equation.

UNIT V PARTIAL DIFFERENTIAL EQUATIONS 12

Formation of partial differential equations – Solutions of standard types of first order partial differential equations - Lagrange’s linear equations - Solutions of homogeneous and Non homogeneous linear partial differential equations of second and higher order with constant coefficients.

L: 45; T: 15; TOTAL: 60 PERIODS

TEXT BOOKS

1. Grewal.B.S. "Higher Engineering Mathematics", 44th Edition, Khanna Publications, New Delhi, 2017.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2014.

REFERENCES

1. Bali.N.P. and Manish Goyal, "A Text book of Engineering Mathematics", 9th Edition, Laxmi Publications Private Limited, 2017.
2. George B.Thomas, Jr. Ross L.Finney, "Calculus and Analytic Geometry", 9th Edition, Dorling Kindersley Private Limited, 2010.

19SH13C ENGINEERING PHYSICS L T P C
(Common to all B.E. / B.Tech. Degree Programmes) 2 0 0 2

COURSE OUTCOMES

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

CO1: summarize the properties and structures of crystal solids. (K2)
CO2: understand the principle and propagation of different types of waves (K2)
CO3: choose the appropriate Laser technique for industrial and medical applications (K2)
CO4: describe the different types, fabrication, losses of optical fibers and their applications in communication and instrumentation. (K2)
CO5: explain the physical properties of photons & electrons and their applications in different electron microscopes. (K2)

UNIT I CRYSTALLOGRAPHY 6

Lattice, Unit cell, Bravais lattice, Lattice planes - Crystal system - Miller indices – d spacing - Characteristics of SC, BCC, FCC and HCP structures- Crystal defects.

UNIT II WAVES 6

Simple harmonic oscillators - Damped harmonic oscillator - Forced mechanical and electrical oscillators - Transverse wave on a string - Wave equation on a string - Longitudinal waves and wave equation - Acoustics waves

UNIT III LASER 6

Principle of spontaneous emission and stimulated emission, Population inversion, Pumping, Einstein's A and B coefficients – Different types of lasers: gas lasers (CO_2), solid-state lasers (Nd-YAG) - Applications of lasers in science, engineering and medicine.

UNIT IV FIBRE OPTICS 6

Principle – Total internal reflection - Acceptance angle and Numerical aperture - Types of optical fibers - Double crucible technique – Splicing - Losses in optical fibers - Fiber optic communication system - Applications - Fiber optic sensors – Medical Endoscope.

UNIT V QUANTUM PHYSICS 6

Black Body Radiation - Matter Waves - Heisenberg's uncertainty principle - Schrodinger's wave equation - Particle in one dimensional box - Electron microscope - Scanning electron microscope - Transmission electron microscope.

L: 30; TOTAL: 30 PERIODS

TEXT BOOKS

1. David Halliday, Robert Resnick, Jearl Walker, "Fundamentals of Physics", 11th Edition, John Wiley & Sons Inc.USA, 2018.
2. Arthur Beiser, "Concepts of Modern Physics", 7th Edition, Mc-Graw Hill Publications Private Limited, 2017.
3. D. J. Griffiths, "Quantum mechanics", 2nd Edition, Cambridge University Press, 2014.

REFERENCES

1. Renk, Karl.F "Basics of laser physics", 2nd Edition, Springer international publishing, 2017.
2. H. J. Pain,Patricia Rankin "Introduction to vibration and waves", 1st Edition, Wiley, 2015
3. K.S.Mathur, "Fundamentals of Fiber Optics", 1st Edition, Zorba books, 2018.

19SH14C ENGINEERING CHEMISTRY L T P C

(Common to all B.E. / B.Tech. Degree Programmes) 2 0 0 2

COURSE OUTCOMES

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

CO1: identify the various water treatment technique for domestic and industrial purpose. (K2)

CO2: understand the various isotherms, kinetics in surface chemistry and catalysis. (K2)

CO3: acquire the knowledge of electrochemistry and corrosion and its control. (K2)

CO4: familiar with the various novel organic material used in electronics industry. (K2)

CO5: understand the principle, components and working of various analytical instruments. (K2)

UNIT I WATER TREATMENT 6

Hardness - Estimation of hardness of water – Specifications for drinking water (BIS and WHO standards) - Softening of water: External and Internal treatments of water – Desalination - Methods of treatment of municipal water - Waste water treatments: primary, secondary and tertiary

UNIT II SURFACE CHEMISTRY AND CATALYSIS 6

Adsorption – Types - Freundlich's adsorption isotherm – Langmuir's adsorption isotherm – contact theory – Kinetics of surface reactions - Unimolecular reactions - Applications of adsorption on pollution abatement.

Catalysis: Catalyst – Types of catalysis – Criteria – Autocatalysis – Acid base catalysis – applications - Catalytic convertor – Enzyme catalysis – Michaelis – Menten equation.

UNIT III ELECTROCHEMISTRY AND CORROSION 6

Electrode potential-Nernst Equation-reference electrode - glass electrode - measurement of pH – electrochemical series – significance – Conductometric titrations (strong acid vs strong base and weak acid vs strong base)

Corrosion: Types of corrosion - Factors influencing corrosion – Corrosion control – Sacrificial anode and impressed current cathodic methods – Corrosion inhibitors

UNIT IV ELECTRONIC MATERIALS 6

Organic semiconducting materials: advantages- p-type and n-type semiconducting materials – pentacene – fullerens-C-60; organic light emitting polymer: polyvinylidene fluoride - OLED material – polyphenylene vinylene - micro and nano sensors - fundamentals of sensors, biosensor - chemical sensors

UNIT V ANALYTICAL TECHNIQUES 6

Spectroscopy:Principle, instrumentation and applications of UV-Visible and IR spectroscopy. chromatography: - HPLC (Principle, instrumentation and applications of HPLC and gas chromatography - Flame photometry – Estimation of sodium and potassium by Flame photometry.

L: 30; TOTAL: 30 PERIODS

TEXT BOOKS

1. Jain P.C. and Jain. M., “Engineering Chemistry”, Dhanpat Rai Publishing Company, 16th Edition, New Delhi, 2016.
2. S.S Dara and S.S Umare, A Text Book of Engineering Chemistry, S.Chand & Company Limited, 20th Edition, 2018.

REFERENCES

1. P. Brezonik, W. Arnold, Water Chemistry: An Introduction to the Chemistry of Natural and Engineered Aquatic Systems, Oxford Press, 6th Edition, 2017.
2. B.R. Puri, L.R. Sharma, M.S. Pathania, Vishal, Principles of Physical Chemistry, Vishal Publishing Co., Punjab, 47th Edition, 2017.
3. S. Crouch, D. Skoog, F Holler, Principles of Instrumental Analysis Hardcover, 2017.
4. H. Klauk, “Organic Electronics: Materials, manufacturing and applications”, Wiley - VCH, 2016

19SH15C ENGINEERING GRAPHICS L T P C

(Common to all B.E. / B.Tech. Degree Programmes) 2 0 4 4

COURSE OUTCOMES

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

CO1: familiarize with the fundamentals of Engineering graphics and construct the engineering curves. (K2)

CO2: construct the orthographic projections of points, straight lines and lamina (K2)

CO3: draw the projections of simple solids in different positions. (K3)
CO4: visualize the sectional views and surface areas of various solids. (K3)
CO5: perform freehand sketching and prepare elementary 2-D and 3D sketches of simple solids. (K3)

INTRODUCTION **5**

Principles of Engineering Graphics – significance. Usage of Drawing Instruments. Lettering and dimensioning exercise. First angle projection should be followed for all the topics except projection of points.

UNIT I ENGINEERING CURVES **17**

Construction of ellipse, parabola and hyperbola using eccentricity method– Construction of cycloids, Epi and Hypo-cycloids - construction of involutes for square and circle –Tangent and Normal to the above curves.

UNIT II ORTHOGRAPHIC PROJECTIONS **17**

Principle of orthographic projections – Conventions - First angle and third angle projections. Projections of points placed in all quadrants – projections of straight lines – inclined to both reference planes - determination of true length and inclinations. Projections of regular polygonal surfaces and circular lamina inclined to both reference planes.

UNIT III PROJECTIONS OF SOLIDS **17**

Projections of simple solids like prisms, pyramids, cylinder and cone - axis inclined to one reference plane - change of position method.

UNIT IV SECTIONS OF SOLIDS AND DEVELOPMENT OF SURFACES **17**

Sectioning of simple solids – Axis perpendicular to horizontal plane- Drawing sectional views with true shape of the section.

Development of lateral surfaces of truncated solids – Prisms, pyramids, cylinder and cone.

UNIT V ISOMETRIC PROJECTIONS AND FREE HAND SKETCHING **17**

Principles of isometric projection – isometric scale – isometric projections of simple solids like prism, pyramid, cone and cylinder – Combination of solids. Orthographic views of simple components by Free hand drawing - Transferring measurement from the given object to the free hand sketches.

L: 30; P: 60; TOTAL: 90 PERIODS

TEXT BOOKS

1. Bhatt N.D, “Engineering Drawing”, 53rd Edition, Charotar Publishing House, 2014.
2. Shah M.B and Rana B.C, “Engineering Drawing”, Pearson Education, 2nd Edition, 2009.

REFERENCES

1. Agrawal B. & Agrawal C.M., Engineering Graphics, TMH Publication, 2nd Edition, 2013
2. Narayana K.L. & Kannaiah P, Text book on Engineering Drawing, Scitech Publishers, 2010.
3. Gopalakrishna K.R, “Engineering Drawing”, Subhas Publications, 32nd Edition, 2017.

19SH16C	**ENGINEERING PHYSICS AND ENGINEERING CHEMISTRY LABORATORY**	**L T P C 0 0 3 1.5**

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

PART A – ENGINEERING PHYSICS LABORATORY

COURSE OUTCOMES

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

CO1: demonstrate the different phenomenon exhibited by the waves. (K2)

CO2: interpret the production of ultrasounds and the variation of velocity of ultrasounds with respect to different medium. (K2)

CO3: illustrate the electrical properties of materials. (K2)

LIST OF EXPERIMENTS

1. Determination of thickness of a thin wire – Air wedge method.
2. Determination of velocity of sound and compressibility of the liquid – Ultrasonic Interferometer.
3. Determination of Dispersive power of a prism using Spectrometer.
4. Determination of angle of divergence of laser beam and acceptance angle, numerical aperture of optical fibre.
5. Determination of acceleration due to gravity using compound pendulum.
6. Determination of (a) spring Constant (b) Value of g and (c) Modulus of Rigidity of a spring by studying motion of a spring.
7. Determination of specific resistance of the coil using Carey-Foster's bridge.

- A minimum of FIVE experiments shall be offered.

REFERENCES

1. David Loyal, " Physics laboratory" 4th Edition, Cengage learning, 2013
2. Sesha Sai Kumar Vemula, "Engineering Physics lab manual" 1st Edition, LAP LAMBERT Academic Publishing, 2017

PART B - ENGINEERING CHEMISTRY LABORATORY

COURSE OUTCOMES

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

CO 1: determine various water quality parameters. (K2)

CO 2: quantify different ions by different analytical techniques. (K2)

CO3: determine the rate of corrosion of mild steel plate. (K2)

CO4: verify the freundlich adsorption isotherm. (K2)

LIST OF EXPERIMENTS

1. Estimation of hardness of water sample by EDTA method.
2. Estimation of iron (Fe^{2+}) by dichrometric method.
3. Determination of rate of corrosion of mild steel plate by weight loss method.
4. Estimation of hydrochloric acid by conductometric method.
5. Estimation of mixture of acids by conductometric method.

6. Determination of purity of simple organic compounds using HPLC- (Demo).
7. Estimation of iron (Fe^{2+}) by spectrophotometric method.
8. Verification of Freundlich adsorption isotherm by using oxalic acid in activated charcoal.

P: 45; TOTAL: 45 PERIODS

- A minimum of FIVE experiments shall be offered.
- Laboratory classes on alternate weeks for Physics and Chemistry.

REFERENCES

1. D.C. Harris "Quantitative Chemical Analysis: International Edition", W.H.Freeman, 9th Edition, 2016.
2. A.I. Vogel, A.R. Tatchell, B.S. Furnis, A.J. Hannaford , P.W.G.Smith, Vogel's Textbook of Practical Organic Chemistry, Pearson Education Limited, England, 8th Edition, 2015.
3. M. Nath, Inorganic Chemistry: A Laboratory Manual, Alpha Science, New Delhi, 2016.

19SH17C	**ENGINEERING PRACTICE LABORATORY**	**L T P C**
	(Common to all B.E. / B.Tech. Degree Programmes)	**0 0 4 2**

PART A - MECHANICAL LABORATORY

COURSE OUTCOMES

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

CO1: prepare different carpentry joints. (K3)
CO2: prepare pipe connections with different joints for domestic applications. (K3)
CO3: make simple components using sheet metal (K3)
CO4: make components using machining operations (K3)
CO5: explain the types of welding processes (K2)
CO6: discuss the applications of 3D printing and injection moulding processes (K2)

LIST OF EXPERIMENTS

I. CARPENTRY PRACTICES **5**

1. Study of the joints in roofs, doors, windows and furniture.
2. Hands on exercise with application

II. PLUMBING PRACTICES **5**

1. Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
2. Study of pipe connections requirements for pumps and turbines.
3. Preparation of plumbing line sketches for water supply and sewage works.
4. Hands on exercise with application

III. SHEET METAL PRACTICES **5**

1. Forming and Bending
2. Model making: Tray, Conical Funnel etc.

IV. MACHINING PRACTICES **5**

1. Simple Turning
2. Drilling Practice
3. Model making: Shaft, stiffener plate, square flange, etc.
4. Demonstration of machining process in Vertical Machining Centre (VMC)

V. METAL JOINING PROCESS **5**

1. Demonstration of Gas, Arc and TIG Welding

VI. ADDITIVE MANUFACTURING AND INJECTION MOULDING PROCESSES **5**

1. Demonstration of 3D Scanning and Printing
2. Demonstration of Injection Moulding process

P: 30; TOTAL: 30 PERIODS

TEXT BOOK

1. Bawa H.S, "Workshop Practice", Tata McGraw Hill Publishing Company Limited, 2007

REFERENCES

1. Ramesh Babu V, "Engineering Practices Laboratory Manual", Revised Edition, VRB Publishers Private Limited, Chennai, 2014.
2. Jeyachandran K, Natarajan S. and Balasubramanian S, "A Primer on Engineering Practices Laboratory", Anuradha Publications, 2007.
3. Jeyapoovan T, Saravanapandian M. and Pranitha S, "Engineering Practices Lab Manual", Vikas Publishing House Private Limited, 2006.
4. Rajendra Prasad A and Sarma PMMS, "Workshop Practice", Sree Sai Publication, 2002
5. Kannaiah P and Narayana KL, "Manual on Workshop Practice", Scitech Publications, 1999.

PART B – ELECTRICAL AND ELECTRONICS LABORATORY

COURSE OUTCOMES

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

CO1: perform residential house wiring (K2)
CO2: identify faults in any electrical appliances (K2)
CO3: measure energy and resistance to earth of electrical equipment (K2)
CO4: measure AC signal parameters using CRO (K2)
CO5: apply soldering for electronic circuit formation in PCB (K2)

LIST OF EXPERIMENTS

ELECTRICAL

1. Residential House Wiring using Switches, Fuse, Indicator, Lamp and Energy Meter.
2. Stair Case Wiring Connections
3. Measurement of Energy using Energy Meter for Single Phase System.
4. Measurement of Earth Resistance using Electrical Equipment.

5. Study of Emergency Lamp, Choke, Starter, Fan and Iron Box
6. Coil Rewinding for Transformer and Fan using Rewinding Machine.
7. Connection of protective devices

ELECTRONICS

8. Study of Resistor, capacitor and inductor
9. Study and Operation of Digital Multimeter, Function/Signal Generator and Regulated Power Supply.
10. Measurement of AC signal parameter (Peak-Peak, RMS, Period and Frequency) using CRO and DSO.
11. Soldering Practice
12. Study of logic gates AND, OR, NOT, NAND, NOR and EXOR.
13. Half Wave Rectifier and Full Wave Rectifier.

P: 30; TOTAL: 30PERIODS

REFERENCES

1. Jeyachandran K, Natarajan S and Balasubramanian S, “A Primer on Engineering Practices Laboratory”, Anuradha Publications, 2007.
2. Jeyapoovan T, Saravanapandian M and Pranitha S, “Engineering Practices Lab Manual”, Vikas Publishing House Pvt. Ltd, 2006.
3. Bawa H.S., “Workshop Practice”, Tata McGraw – Hill Publishing Company Limited, 2007.
4. Rajendra Prasad A and Sarma P.M.M.S., “Workshop Practice”, Sree Sai Publication, 2002.
5. Kannaiah P and Narayana K.L., “Manual on Workshop Practice”, Scitech Publications, 1999.

19EE21C	**PROFESSIONAL ENGLISH**	**L T P C**
	(Common to all B.E. / B.Tech. Degree Programmes)	**2 0 0 2**

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO 1: integrate and apply the acquired skills in real life situation. (K3)
CO 2: write effectively in any professional contexts. (K3)
CO 3: enhance the vital sub-functions of communication in any formal situation. (K3)
CO 4: participate actively in any informal and formal discussion. (K3)
CO 5: recall the acquired skills and apply them in their work place. (K2)

UNIT I **6**

Standard Abbreviations - If Conditionals - Presenting articles based on newspaper reading - Listening for specific information - Argumentative essay.

UNIT II **6**

One word substitution - Rearranging the jumbled phrases of sentences – Chart Description - Business Letters for Quotations and Clarification.

UNIT III **6**

Idioms and Phrases - Direct & Indirect Speech - Business Letters for Placing orders and Making Complaints - Process Description.

UNIT IV **6**

Synonyms **-** Group Discussion (Uses – Structure – Strategies – Team Work – Positive & Negative Body Languages – Samples - Demo) - Proposal Writing.

UNIT V **6**

Error Spotting (Based on Concord, Pronouns, Articles & Adverb Placement) - Job Application Letter & Resume Preparation - Circular and Minutes of the meeting - Reading Comprehension.

Suggested Activity: Career Analysis – Herein the students will be required to submit a report about their dream career / company of their choice. This will be followed by a presentation of the same in the class.

L: 30; TOTAL: 30 PERIODS

TEXT BOOKS

1. Board of editors. "Fluency in English A Course book for Engineering and Technology", Orient Blackswan, Hyderabad, 2016.
2. Bovee, Courtland, L., John V.Thill. "Business Communication Today", 13th Edition, Pearson Education, New Delhi, 2018.

REFERENCES

1. Lester Mark and Larry Beason, "Hand book of English Grammar and Usage", McGraw Hill Education, 1st Edition, 2017.
2. Raman, Meenakshi and Sharma, Sangeetha, "Technical Communication Principles and Practice", Oxford University Press, New Delhi, 2014.

19EE22C CALCULUS, PROBABILITY AND STATISTICS **L T P C**
2 1 0 3

COURSE OUTCOMES

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

CO1: compute double and triple integrals (K2)
CO2: analyze the concepts related to vector calculus (K3)
CO3: use the concepts of multivariate random variables (K2)
CO4: calculate the various measures of dispersion (K2)
CO5: apply all aspects of appropriate testing techniques (K2)

UNIT I MULTIPLE INTEGRALS **9**

Double integration – Cartesian and polar coordinates-Change of order of integration - Area as double integral-Volume as triple integral.

UNIT II VECTOR CALCULUS 9

Gradient, Divergence and Curl –Directional derivatives – Irrotational and solenoidal vector fields -Vector integration–Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (excluding proofs)–Simple applications involving cubes and rectangular parallelopipeds.

UNIT III PROBABILITY 9

Random variable - Discrete and continuous random variables–Moments-Moment generating function and their properties - Joint distributions-Marginal and conditional distributions -Covariance-Correlation and regression.

UNIT IV STATISTICS 9

Mean, median, mode and standard deviation–Moments–Skewness –Kurtosis - Correlation – Regression lines.

UNIT V TESTING OF HYPOTHESIS 9

Sampling distributions -Tests for single mean, Proportion, Difference of means (for large samples) – Tests for single variance and equality of variances–t-test, F-test.

L: 30; T: 15; TOTAL: 45 PERIODS

TEXT BOOKS

1. Grewal.B.S., "Higher Engineering Mathematics", Khanna Publications, 44th Edition, New Delhi, 2017.
2. Ronald E.Walpole, Raymond H.Myres, Sharon L.Myres, Keying E. Ye, "Probability and Statistics for Engineers and Scientists", Pearson Education Private Limited, 9th Edition, Delhi, 2011.

REFERENCES

1. Gupta S.C, and Kapoor V.K, "Fundamentals of Mathematical Statistics: A modern approach", Sultan Chand & Sons, 10th Edition, Delhi, 2000.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India, 10th Edition, 2011.
3. Richard Arnold Johnson, Irwin Miller, John E Freund, "Miller and Freund‟s Probability and Statistics for Engineers", 9th Edition, Pearson Education Private Limited, 2016.
4. Robert V.Hogg, Joseph W.Mckean, Allen Thornton Craig, "Introduction to Mathematical Statistics", 8th Edition, Pearson Education Private Limited, 2018.

19EE23C WAVES, OPTICS AND SEMICONDUCTOR PHYSICS L T P C
2 0 0 2

COURSE OUTCOMES

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

CO1: gain knowledge on different types of oscillations and its application in electrical systems (K2)

CO2: understand the laws, phenomenon and applications of light rays in engineering fields (K2)

CO3: infer the principles of quantum physics to understand the properties of semiconductor materials (K2)

UNIT I NON-DISPERSIVE TRANSVERSE AND LONGITUDINAL WAVES 6

Wave motion – types of waves – wave equations – differential equations of wave motions - SHO in electrical systems - damped SHM in an electrical circuit- forced oscillations – behaviour of forced oscillator – resonance - impedance matching

UNIT II GEOMETRICAL OPTICS 6

Fermat's principle on laws of reflection and refraction – mirage effect – Brewster's angle – total internal reflection – mirror and lenses – optical instruments – compound microscope – constant deviation spectrometer – matrix methods – refraction and translation matrix.

UNIT III WAVE OPTICS 6

Huygen's theory – principle – superposition of waves – interference of light by wavefront splitting and amplitude splitting – Young's double slit – Newton's rings – Michelson's interferometer – Fraunhofer diffraction – single slit – circular aperture – resolving power of plane transmission grating – Reyleigh's criterion – Limit of resolution of the eye.

UNIT IV INTRODUCTION TO SOLIDS 6

Free electron theory of metals, fermi level, density of states – Types of electronic materials: metals, semiconductors and insulators.

UNIT V SEMICONDUCTORS 6

Intrinsic and extrinsic semiconductors – Dependence of Fermi level on carrier - concentration and temperature - Carrier generation and recombination – Carrier transport: diffusion and drift, p -n junction – LED: device structure, materials, characteristics.

L: 30; TOTAL: 30 PERIODS

TEXT BOOKS

1. H.J.Pain, Patricia Rankin "Introduction to vibration and waves", Wiley, 1st Edition, 2015.
2. D. J. Griffiths, "Quantum mechanics", Cambridge University Press, 2nd Edition, 2014.
3. K.S.Mathur, "Fundamentals of Fiber Optics", Zorba books, 1st Edition, 2018.

REFERENCES

1. Arthur Beiser, "Concepts of Modern Physics", McGraw Hill Publications Private Limited, 7th Edition, 2017.
2. Eugene Hecht, "Optics", Pearson Education, 5th Edition, 2016
3. Donald Neamen, Dhrubes Biswas, Mc Graw Hill Education, 4th Edition, 2017

19EE24C CHEMISTRY FOR ELECTRICAL ENGINEERING L T P C
2 0 0 2

COURSE OUTCOMES

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

CO1: understand the construction and uses of various energy storage devices. (K2)
CO2: familiar with different polymers used in electrical industry. (K2)
CO3: understand the principle and process of various surface coatings. (K2)
CO4: know about the electrical insulating materials. (K2)

CO5: gain knowledge about the applications of nanomaterials in energy storage devices. (K2)

UNIT I ENERGY STORAGE DEVICES 6

Batteries: Types of batteries – primary battery-dry cell- secondary batteries - lead acid, lithium-ion battery. Fuel cells: H_2-O_2 fuel cell, MOFC and MFC. Super capacitors - construction - Applications.

UNIT II POLYMER IN ELECTRICAL INDUSTRY 6

Dielectric polymers: origin - ferroelectrics, piezoelectric and pyroelectric-application. Characteristics and structural requirements of piezoelectric polymers - Polyvinylidene fluoride - Trifluoroethylene and tetrafluoroethylene copolymers – Nylon -11.

UNIT III SURFACE COATING 6

Introduction - metallic coating - determination of throwing power-electroplating of chromium- Electroless plating- nickel plating. Paints; constituents - multilayer coating on aluminium - zinc pasivation - anodizing.

UNIT IV ELECTRICAL INSULATING MATERIALS 6

Insulating material- requirement - properties – testing - dissolved gas analysis, furan analysis, degree of polymerization. Organic and inorganic insulation material- natural and synthetic.

UNIT V NANOTECHNOLOGY 6

Nanoparticles: synthesis, properties and applications–Lighting/Displays, Batteries, Fuel Cells, Photovoltaic Cells and Electric double-layer capacitors (EDLC) - Toxicity.

L: 30; TOTAL: 30 PERIODS

TEXT BOOKS

1. P.C. Jain P.C. and M. Jain, “Engineering Chemistry”, Dhanpat Rai Publishing Company, 16th Edition, New Delhi, 2016.
2. S.S Dara and S.S Umare, A text Book of Engineering Chemistry, S.Chand & Company Ltd, 20th Edition, 2018.

REFERENCES

1. R. Huggins, “Energy Storage: Fundamentals, Materials and Applications”, Springer International Publishing, 2nd Edition, 2016.
2. Arthur A. Tracton, “Coating materials and surface coatings” CRC press, Taylor & Francis, 4th Edition, 2016.
3. J.G.Drobny, Polymers for Electricity and Electronics: Materials, Properties, and Applications, Jhon Wiley & Sons, New Jersey, 2012.
4. J.Martinez-Vega, Dielectric Materials for Electrical Engineering, John Wiley & Sons, New Jersey, 2013.

19EE25C PROBLEM SOLVING TECHNIQUES L T P C
3 0 0 3

COURSE OUTCOMES

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

CO 1: develop algorithmic solutions to simple computational problems. (K3)
CO 2: make appropriate decisions and solve problems using looping techniques.(K2)
CO 3: solve problems using array and functions. (K3)
CO 4: implement various sorting techniques. (K3)
CO 5: implement various searching techniques. (K3)

UNIT I BASICS OF PROBLEM SOLVING 9

Overview of programming: Problem Solving in Everyday Life, Types of Problem, Computer-based problem solving, Difficulties in problem solving, Program design, implementation issues, programming environment, Data Storage and Communication with Computer, Organizing the Problem. Algorithms for problem solving: Algorithms and flow charts, flowchart symbols, design of algorithms for simple and scientific problems, divide and conquer strategy.

UNIT II BASIC TECHNIQUES 9

Sequential Logic Structure, Decision Making, Looping Techniques, Multi-Way decision Making, Solving With Modules.

UNIT III ARRAYS AND FUNCTIONS 9

Arrays: one dimensional array – Two dimensional arrays – Multi dimensional arrays. Character arrays and Strings: Declaring and initializing String Variables – Comparison of two strings – String handling functions. User defined Functions: Definition – Declaration – Function calls – Category of Functions – Recursion - Storage Classes.

UNIT IV SORTING TECHNIQUES 9

Sorting: Bubble Sort, Selection Sort, Insertion Sort, Postman Sort, Quick Sort, Merge Sort, Radix Sort, Applications

UNIT V SEARCHING TECHNIQUES 9

Searching algorithms: Linear search, Binary search, Fibonacci search, Golden-ratio selection, Golden section search method, Applications

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Maureen Sprankle and Jim Hubbard, “Problem Solving and Programming Concepts”, Prentice Hall, 9th Edition, 2012.
2. Harsha Priya, R. Ranjeet, — Programming and Problem Solving Through C Language, Firewall/Laxmi Publications (P) Ltd., New Delhi, 2015.

REFERENCES

1. Pradip Dey, Manas Ghosh, Fundamentals of Computing and Programming in C, 2nd Edition, Oxford University Press, 2013.

2. M.G.Venkateshmurthy, Programming Techniques through C: A Beginner's Companion, Pearson Education, Canada, 2009.
3. Ashok.N.Kamthane, Computer Programming, Pearson Education, India, 2011.

19EE26C BASIC CIVIL AND MECHANICAL ENGINEERING L T P C
4 0 0 4

COURSE OUTCOMES

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

CO1: discuss the materials and measurement techniques used in civil engineering. K2)
CO2: describe the fundamental elements of civil engineering structures. (K2)
CO3: discuss the components and working principle of power plants.(K2)
CO4: explain various power generation systems in vehicles. (K2)
CO5: discuss the working principle of refrigeration and air conditioning system. (K2)

UNIT I SURVEYING AND CIVIL ENGINEERING MATERIALS 12

Surveying: Objects – classification – principles – measurements of distances – angles – leveling – determination of areas– contours - examples.
Civil Engineering Materials: Bricks – stones – sand – cement – concrete – steel - timber - modern materials.

UNIT II BUILDING COMPONENTS AND STRUCTURES 12

Foundations: Types of foundations - Bearing capacity and settlement – Requirement of good foundations.
Civil Engineering Structures: Brick masonry – stonemasonry – beams – columns – lintels – roofing – flooring – plastering – floor area, carpet area and floor space index - Types of Bridges and Dams – water supply - sources and quality of water - Rainwater harvesting - introduction to high way and railway engineering.

UNIT III POWER PLANTS 12

Power Plants – Classification – Construction and working principle - steam, Gas, Diesel, Hydroelectric, Nuclear, Wind Energy and Solar Power plants.

UNIT IV VEHICLE TECHNOLOGIES 12

Internal combustion engines-Classification – Construction - Working principle- Four stroke and two stroke cycles - Comparison of four stroke and two stroke engines.
Electric Vehicle - Hybrid vehicle- Drivetrain configurations - Fuel cell Vehicles.

UNIT V REFRIGERATION AND AIR CONDITIONING SYSTEM 12

Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system-Layout of typical domestic refrigerator-Window and Split type room Air conditioner.

L:60; TOTAL: 60 PERIODS

TEXT BOOKS

1. Shanmugam G and Palanichamy M.S, "Basic Civil and Mechanical Engineering", Tata McGraw Hill Publishing Co., New Delhi, 2016.

2. Shanmuga Sundaram S and Mylsamy K, “Basic Civil and Mechanical Engineering”, Cengage Learning, 2011.

REFERENCES

1. Ramamrutham S, “Basic Civil Engineering”, Dhanpat Rai Publishing Co. (P) Ltd, 2013.
2. Seetharaman S, “Basic Civil Engineering”, Anuradha Agencies, 2005.
3. Amir Khajepour, Saber Fallah M, Avesta ,“Electric and Hybrid Vehicles: Technologies, Modeling and Control – A Mehatronic approach”, Wiley, 2014
4. Shantha Kumar S R J, “Basic Mechanical Engineering”, Hi-tech Publications, 2013.

19EE27C	OPTICS AND SEMICONDUCTOR PHYSICS AND CHEMISTRY LABORATORY	L T P C 0 0 3 1.5

PART A OPTICS AND SEMICONDUCTOR PHYSICS LABORATORY

COURSE OUTCOMES

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

CO 1: demonstrate the properties of light waves (K2)

CO 2: Illustrate the properties of semiconducting materials (K2)

LIST OF EXPERIMENTS

1. Determination of wavelength of Hg source using diffraction grating
2. Determination of wavelength of laser source and particle size of lycopodium powder
3. Determination of radius of curvature of a plano-convex lens – Newton’s rings
4. Determination of Hall coefficient
5. Bandgap determination of a semiconductor
6. V-I Characteristics of p-n junction diode
7. Characteristics of LED

- A minimum of FIVE experiments shall be offered.

REFERENCES

1. Dr.Samir Kumar Ghosh, “A text book of Practical Physics” New Central Book Agency, 4th Edition, 2017
2. David Loyal, “ Physics laboratory”, Cengage learning, 4th Edition, 2013
3. Sesha Sai Kumar Vemula, “Engineering Physics lab manual”, LAP LAMBERT Academic Publishing, 1st Edition, 2017

PART B CHEMISTRY LABORATORY

COURSE OUTCOMES

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

CO 1: quantify different ions by different analytical techniques. (K2)
CO 2: determine the distribution coefficient of analyte. (K2)
CO3: estimate the quality of transformer oil by different analytical techniques. (K2)
CO4: modify the surface of materials to prevent the corrosion. (K3)

LIST OF EXPERIMENTS

1. Estimation of copper (II) by Spectrophotometer.
2. Estimation of Fe^{2+} by Potentiometric titration.
3. To determine the distribution coefficient of iodine between CCl_4 and water at room temperature.
4. Saponification/acid value of vegetable oil.
5. Electroplating of copper on steel.
6. Determination of solubility product of given samples.
7. Condition assessment of transformer oil using spectrophotometer.

P: 45; TOTAL: 45 PERIODS

- A minimum of FIVE experiments shall be offered.
- Laboratory classes on alternate weeks for Physics and Chemistry.

REFERENCES

1. Harris D.C, "Quantitative Chemical Analysis: International Edition", 9th Edition, W.H.Freeman, 2016.
2. A.I. Vogel, A.R. Tatchell, B.S. Furnis, A.J. Hannaford , P.W.G. Smith, Vogel's Textbook of Practical Organic Chemistry, Pearson Education Limited, England, 8th Edition, 2015.
3. M. Nath, Inorganic Chemistry: A Laboratory Manual , Alpha Science, New Delhi, 2016.

19EE27C PROBLEM SOLVING TECHNIQUES LABORATORY L T P C
0 0 4 2

COURSE OUTCOMES

Upon completion of this course, the students will be able to
CO 1: solve simple and Complex problems. (K3)
CO 2: solve sorting and searching problems. (K3)

LIST OF EXERCISES

Programs using simple logics and switch cases

1. Solve problems such as temperature conversion, student grading, interest calculation.
2. Find the roots of a quadratic equation
3. Design a simple arithmetic calculator. (Use switch statement)
4. Design a traffic light controller (Use switch statement)

Programs using Control Structures

5. Perform the following operations:
   a. Generate Pascal's triangle.

b. Construct a Pyramid of numbers.

6. Generate of the first n terms of the Fibonacci sequence and prime sequence.
7. Compute Sine series and Cosine series.
8. Find the 2's complement of a binary number.

Programs using Arrays

9. Perform the following operations:
   a. Matrix addition.
   b. Transpose of a matrix.
   c. Matrix multiplication by checking compatibility

Programs to manipulate Strings

10. Perform the following operations on a string:
    a. Insert a sub-string into main string at a given position.
    b. Delete n characters from a given position in a string.
    c. Check whether the given string is palindrome or not.
    d. Replace a character of string either from beginning or ending or at a specified location.

Programs using Functions

11. Perform the following operations: (Use recursive functions)
    a. Find the factorial of a given integer.
    b. Find the GCD (Greatest Common Divisor) of two given integers.
    c. Solve the Towers of Hanoi problem.

Programs using sorting and searching techniques

12. Implement Insertion Sort, Merge Sort
13. Implement Linear search, Binary search

P: 60; TOTAL: 60 PERIODS

Software Requirement: Turbo C / Python

19EE29C	**COMMUNICATION SKILLS LABORATORY**	**L T P C**
	(Common to all B.E. / B.Tech., Degree Programmes)	**0 0 2 1**

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO 1: Listen and respond effectively to interact at different situations fluently (K2)
CO2: Excel appropriately in professional contexts. (K3)
CO3: Acquire the sub-skills required for paper presentations and group discussions which will help them to excel in their workplace. (K3)

UNIT I **10**

Lab session: Listening and responding to audio files
Practice session: Mini Presentation related to Business English & Picture description.

UNIT II **10**

Lab session: Role Play – News Reader
Practice session: Resume Preparation

UNIT III **10**

Lab session: Listening to audio files related to soft skills.
Practice session: Practicing Power point presentation, Group discussion.

P: 30; TOTAL: 30 PERIODS

REFERENCES

1. Dutt P. Kiranmai and Rajeevan Geeta, "Basic Communication Skills", Foundation Books, 2013.
2. Comfort, Jeremy, et al. "Speaking Effectively, Developing Speaking Skills for Business English", Cambridge University Press, Cambridge: Reprint 2011.
3. Rizvi.M.Ashraf, "Effective Technical Communication", The MC-Graw Hill Education Private Limited Companies, New Delhi, 2010.

19GN01C **INNOVATION THROUGH DESIGN THINKING** **L T P C**
1 0 2 2

COURSE OUTCOMES

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

CO1: To discuss the design thinking process and innovation. (K2)
CO2: Practice design thinking process through a multidisciplinary task. (K3)

UNIT I **BASICS OF DESIGN THINKING PROCESS** **15**

Design thinking process basics-Ideation tools-case studies.

UNIT II **PRACTICING DESIGN THINKING PROCESS** **30**

Real world problem selection-Practicing the preliminary stages of Design Thinking Process - work presentation.

L: 15; P: 30; TOTAL: 45 PERIODS

REFERENCES

1. Falk Uebernickel, Li Jiang, Walter Brenner, Britta Pukall, Therese Naef, "Design Thinking: The Handbook", WS Professional, 2020
2. Pavan Soni, "Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem solving", Penguin Random House, 2020
3. D.M. Arvind Mallik, "Design Thinking for Educators", Notion Press, 2019
4. Michael Lewrick, "The Design Thinking Playbook", Wiley, 2019
5. Kathryn Christopher, "Design Thinking in Engineering", Kendall Hunt Publishing Company, 2019
6. Robert Curedale, "Design Thinking Process & Methods" 5th Edition, Design Community College Inc, 2019
7. David Lee, "Design Thinking in the Classroom", Ulysses Press, 2018
8. Jimmy Jain, "Design Thinking for Startups", Notion Press, 2018
9. Monika Hestad Silvia Rigoni Anders Grnli, "The Little Booklet on Design Thinking: An Introduction", 2nd Edition, Zaccheus Entertainment, 2017
10. Scott Swan, Michael G. Luchs and Abbie Griffin, "Design Thinking: New Product

Development Essentials", Wiley-Blackwell, 2016
11. Thomas Lockwood, "Design Thinking: Integrating Innovation, Customer Experience, and Brand Value", Allworth Press, 2009

MENTOR ACTIVITIES:

Educating the design thinking process: basics, Ideation tools and empathy map through case studies - presentation	10 Hours
Forming multidisciplinary batches among the students- Guide the batches to select a real-world task- Apply and practice the different stages of Design thinking process to bring out innovative solutions	20 Hours
Evaluating the students' activities through their presentations	

End semester Assessments can be made through:

- Design Thinking presentation(PowerPoint format)
- Design Thinking poster preparation and presentation (PDF format, in color and monochrome, printable in A3 size)

Other points:

This course is for all department students

- A class/section should be with all department students
- A course instructor will be responsible for the academic process.
- In a project batch, maximum number of students should be four and no two students from same discipline possibly.
- The course has no pre-requisite and may be offered to second/fourth semester students.

19EE31C FOURIER SERIES AND TRANSFORMS L T P C
2 1 0 3

COURSE OUTCOMES

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

CO 1: Perform Fourier series analysis of the functions (K2)
CO 2: Compute the Fourier transforms of various functions (K2)
CO 3: Calculate the Fourier series solution of Wave and Heat equations (K3)
CO 4: Apply Laplace Transform techniques to solve ordinary differential equations (K3)
CO 5: Solve difference equations using Z-Transform (K3)

UNIT I FOURIER SERIES 9

Dirichlet's conditions–General Fourier series –Half range series–Complex form of Fourier series– Parseval's identity–Harmonic analysis.

UNIT II FOURIER TRANSFORMS 9

Fourier Integral theorem (without proof)–Fourier transform pair–Fourier Sine and Cosine transforms–Properties–Transforms of simple functions–Convolution theorem –Parseval's identity.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9

Classification of second order partial differential equations–Fourier series solutions of one dimensional wave equation –One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (Insulated edges excluded)

UNIT IV LAPLACE TRANSFORMS 9

Definition of Laplace transform and its inverse –Transforms of elementary functions – Properties(excluding proofs) –Transforms of periodic functions –Initial and Final value theorems–Convolution theorem (excluding proof) – Solutions of linear ordinary differential equations of second order with constant coefficients.

UNIT V Z –TRANSFORMS 9

Z– transform –Elementary properties – Inverse Z–transform – Convolution theorem- Initial and final value theorem – Formation of difference equations –Solutions of difference equations using Z–transform.

L: 30; T: 15; TOTAL: 45 PERIODS

TEXT BOOKS

1. Grewal.B.S "Higher Engineering Mathematics", 44th Edition, Khanna Publications, Delhi, 2017.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2011.

REFERENCES

1. Bali.N.P. and Manish Goyal, "A Textbook of Engineering Mathematics", 9th Edition, Laxmi Publications Private Limited., 2014.
2. Ramana B.V, "Higher Engineering Mathematics", Tata Mc-Graw Hill Publishing Company, New Delhi, 2007.
3. Jain.R.K. and Iyengar.S.R.K., "Advanced Engineering Mathematics", 5th Edition, Narosa Publishing House Private Limited, 2016.

19EE32C ELECTRICAL CIRCUIT ANALYSIS L T P C
3 1 0 4

COURSE OUTCOMES

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

CO 1: Describe the basic concepts of electric circuits. (K2)
CO 2: Illustrate the network theorems for DC and AC circuits. (K2)
CO 3: Explain the concepts of resonant circuits. (K2)
CO 4: Discuss the dynamic behavior of electric circuits. (K2)
CO 5: Interpret the performance of three phase electric circuits. (K2)

UNIT I BASIC CIRCUITS ANALYSIS 12

Ohm's Law – Kirchoff's laws – DC and AC Circuits – Real & Reactive Power, Power factor – Resistors in series and parallel circuits – Mesh current and node voltage method of analysis for D.C and A.C. circuits.

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

Network reduction: voltage and current division, source transformation – Star-delta conversion – Thevenin's and Norton's Theorem – Superposition Theorem – Maximum Power Transfer Theorem – Reciprocity Theorem.

UNIT III RESONANCE AND COUPLED CIRCUITS 12

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

UNIT IV TRANSIENT RESPONSE ANALYSIS 12

Transient response of RL, RC and RLC Circuits using Laplace transform for DC input and AC with sinusoidal input.

UNIT V THREE PHASE CIRCUITS & TWO PORT NETWORKS 12

Three phase balanced / unbalanced voltage sources – Analysis of three phase 3-wire and 4- wire circuits with star and delta connected loads, balanced and unbalanced loads – Phasor diagram of voltages and currents – power and power factor measurements in three phase circuits- Overview of two port networks.

L: 45; T: 15; TOTAL: 60 PERIODS

TEXT BOOKS

1. William H.Hayt Jr, Jack E.Kemmerly and Steven M.Durbin, "Engineering Circuits Analysis", Tata McGraw Hill publishers, New Delhi, 2013.
2. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.

REFERENCES

1. Joseph A. Edminister, Mahmood Nahri, "Electric circuits", Schaum's series, Tata McGraw-Hill, New Delhi, 2001.
2. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", Tata McGraw- Hill, New Delhi, 2007.
3. John Bird, "Electrical Circuit Theory and Technology", 4th Edition, Newnes Publication, 2010.
4. Charles K. Alexander, Mathew N.O.Sadik, "Fundamentals of Electric Circuits", 2nd Edition, McGraw Hill, 2004.

19EE33C ANALOG ELECTRONICS L T P C
3 1 0 4

COURSE OUTCOMES

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

CO 1: Infer the different BJT Biasing Circuits and amplifiers. (K2)
CO 2: Analyze the different MOSFET Biasing Circuits and amplifiers. (K2)
CO 3: Infer the characteristics of operational amplifier. (K2)
CO 4: Explain the basic applications of operational amplifier. (K2)
CO 5: Interpret the applications of special ICs and power supply circuits. (K2)

UNIT I DIODE AND BJT CIRCUITS 12

P-N junction diode – I-V characteristics of a diode - half-wave and full-wave rectifiers - Zener Diodes and Regulators - clamping and clipping circuits - Structure and I-V characteristics of a BJT- BJT as an amplifier- biasing circuits- common emitter, common base and common collector amplifiers - Small signal equivalent circuits - high-frequency equivalent circuit- power amplifiers - direct coupled multi-stage amplifier.

UNIT II MOSFET CIRCUITS 12

MOSFET structure - IV characteristics - MOSFET as an amplifier-small signal model-biasing circuits - common-source -common-gate-common-drain amplifiers - small signal equivalent circuits - gain, input and output impedances, trans-conductance, high frequency equivalent circuit.

UNIT III OPERATIONAL AMPLIFIERS AND ITS CHARACTERISTICS 12

Internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product) Idealized analysis of op-amp circuits - Inverting and non-inverting amplifier-differential amplifier, Instrumentation amplifier- integrator, differentiator.

UNIT IV APPLICATIONS OF OP- AMP 12

Active filter- oscillators (Wein bridge and phase shift) - Analog to Digital Conversion-Hysteretic Comparator, Zero Crossing Detector - Comparator - current mirror - Square wave and triangular wave generators - Precision rectifier- Peak detector- P, PI and PID controllers and lead/lag compensator using an op-amp

UNIT V APPLICATION ICS AND POWER SUPPLY 12

555 timers – Monostable and Astable Multivibrators – Schmitt Triggers – IC voltage regulators – LM78XX, 79XX – Variable voltage regulators switching regulators LM317, LM723 -– Switched Mode Power Supply.

L: 45; T: 15; TOTAL: 60 PERIODS

TEXT BOOKS

1. S. Sedra and K. C. Smith, “Microelectronic Circuits”, New York, Oxford University Press, 1998.
2. J. V. Wait, L. P. Huelsman and G. A. Korn, “Introduction to Operational Amplifier theory and applications”, McGraw Hill U. S., 1992.

REFERENCES

1. P. Horowitz and W. Hill, “The Art of Electronics”, Cambridge University Press, 1989.
2. Jacob Millman, Christos Halkias, Chetan Parikh Millman's “Integrated Electronics” McGraw Hill Education; 2 Edition (1 July 2017)
3. David A. Bell “Electronic Devices and Circuits” Oxford; Fifth Edition (30 April 2008)
4. Salivahanan, Kumar “Electronic Devices and Circuits” McGraw Hill Education; Fourth Edition (1 July 2017)
5. D.Roy choudhuri, Shail B. Jain, “Linear Integrated Circuits”, New Age International Publications, 2012.

6. Robert L. Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory", Amazon Asia-Pacific Holdings Private Limited, 2015
7. Thomas L. Floyd, David M. Buchla, "Basic Operational Amplifiers and Linear Integrated Circuits**"** Prentice Hall (January 10, 1999)

19EE34C ELECTRICAL MACHINES – I L T P C
3 0 0 3

COURSE OUTCOMES

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

CO 1: understand the basic concepts of Magnetic circuits (K2)
CO 2: analyze single and three phase Transformer circuits (K2)
CO 3: appraise the concept of electro mechanical energy conversion (K2)
CO 4: understand the operations of DC electrical machines (K2)
CO 5: outline the functions of the motors and its applications (K2)

UNIT I MAGNETIC CIRCUITS 9

Magnetic Circuits – Flux Linkage, Inductance and Energy – Torque – Visualization of magnetic fields produced by a bar magnet and a current carrying coil - through air and through a combination of iron and air; influence of highly permeable materials on the magnetic flux lines - Magnetic Materials, B-H curve of magnetic materials; flux-linkage Vs current characteristic of magnetic circuits; linear and nonlinear magnetic circuits; Hysteresis and Eddy current Loss.

UNIT II ELECTRO MECHANICAL ENERGY CONVERSION 9

Energy stored in a magnetic circuit – Force as a partial derivative of stored energy with respect to position of a moving element – Torque as a partial derivative of stored energy with respect to angular position of a rotating element: Examples - galvanometer coil, relay contact, lifting magnet, rotating element with eccentricity or saliency - Flux density distribution – armature MMF wave – Air gap flux density distribution with armature reaction.

UNIT III DC GENERATOR 9

Construction – Principle of Operation – Lap and Wave windings – EMF Equation – Armature Reaction – Method of Excitation – Commutation – Interpoles and Compensating Winding – Characteristics of DC Generator – Parallel Operation – Losses and Efficiency

UNIT IV DC MOTOR 9

Principle Of Operation – Back EMF – Torque Equation – Types of Motors – Starters and Speed Control – Speed Torque Characteristics – Braking – Losses and Efficiency – Retardation test – Swinburne's Test – Hopkinson's Test – Permanent Magnet DC Motor.

UNIT V TRANSFORMER 9

Construction and Working Principle – Equivalent circuit Parameters – Phasor Diagram – Losses and efficiency – All day efficiency and Voltage Regulation – Sumpner's test – Polarity Test – Separation of Losses – Three Phase transformer-vector groups - types of

connection and their comparative features – Scott connection – Parallel Operation – Auto transformer – Tap Changing Transformer-IEC/IEEE/IS

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Nagrath I. J and Kothari D. P. "Electric Machines", 5th Edition, Tata Mc-Graw Hill Publishing Company Limited, 2017
2. S.K.Bhattacharya "Electrical Machines", 4th Edition, Tata Mc-Graw Hill Publishing Company Limited, 2014.

REFERENCES

1. M.N.Bandyopadhyay, Electrical Machines Theory and Practice, PHI Learning Private Limited, New Delhi, 2009.
2. Fitzgerald. A.E., Charles Kingsely Jr, Stephen D.Umans, 'Electric Machinery', 6th Edition, Tata Mc-Graw Hill Books Company, 2003.
3. P.S. Bimbhra, "Electrical Machinery", Khanna Publishes, 7th Edition, 2011.
4. S.Sarma & K.Pathak "Electric Machines", Cengage Learning India Private Limited, Delhi, 2011.
5. V.K.Metha and Rohit Metha "Principles of Electrical Machines" S.Chand Publications, 2014.
6. "Transformers", 2nd Edition, BHEL, 2003.
7. IEC60076 -Transformer standards, IEC 60034 rotating machines

19EE35C ELECTROMAGNETIC FIELDS L T P C
3 1 0 4

COURSE OUTCOMES

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

CO1: understand the basic laws of electromagnetism. (K1)
CO2: obtain the electric and magnetic fields for simple configurations under static conditions. (K2)
CO3: analyze time varying electric and magnetic fields. (K2)
CO4: understand Maxwell's equation in different forms and different media. (K1)
CO5: investigate the propagation of EM waves in different spaces. (K3)

UNIT I REVIEW OF VECTOR CALCULUS 12

Vector algebra-addition, subtraction, components of vectors, scalar and vector multiplications, triple products, three orthogonal coordinate systems (rectangular, cylindrical and spherical). Vector calculus-differentiation, partial differentiation, integration, vector operator del, gradient, divergence and curl; integral theorems of vectors. Conversion of a vector from one coordinate system to another.

UNIT II STATIC ELECTRIC FIELDS 12

Coulomb's law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, Potential difference, Calculation of potential differences for different

configurations. Electric dipole, Electrostatic Energy and Energy density. Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance, Capacitance of a two wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation.

UNIT III STATIC MAGNETIC FIELDS 12

Biot-Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic potentials. Steady magnetic fields produced by current carrying conductors. Force on a moving charge, Force on a differential current element, Force between differential current elements, Magnetization and permeability, Magnetic boundary conditions, Inductances and mutual inductances.

UNIT IV TIME VARYING FIELDS AND MAXWELL'S EQUATIONS 12

Faraday's law for Electromagnetic induction, Displacement current, Point form of Maxwell's equation, Integral form of Maxwell's equations, Motional Electromotive forces.

UNIT V ELECTROMAGNETIC WAVES 12

Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in Phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors, Skin effect. Poynting theorem- Applications EMI/EMC (qualitative)

L: 45; T: 15; TOTAL: 60 PERIODS

TEXT BOOKS

1. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014.
2. A. Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd, New Delhi, 2009.
3. A. Pramanik, "Electromagnetism-Problems with solution", Prentice Hall India, 2012.

REFERENCES

1. W. Hayt, "Engineering Electromagnetics", McGraw Hill Education, 2012.
2. W.J. Duffin, "Electricity and Magnetism", McGraw Hill Publication, 1990.
3. E.G. Cullwick, "The Fundamentals of Electromagnetism", Cambridge University Press, 1966.
4. B.D.Popovic, "Introductory Engineering Electromagnetics", Addison-Wesley Educational Publishers, International Edition, 1971.
5. Henry W. Ott, "Electromagnetic Compatibility Engineering", Wiley-Blackwell; Revised Edition (11 September 2009)

19EE36C ENGINEERING MECHANICS L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: describe basic laws of mechanics and apply equilibrium principles to solve the problems on statics of particles. (K2)

CO2: draw free body diagram for two dimensional rigid bodies and construct shear force and bending moment diagrams of beam section. (K3)
CO3: determine the centroid and moment of inertia of plane lamina. (K3)
CO4: understand the kinematics of rigid bodies and general plane motion. (K2)
CO5: explain the basic principles and applications of friction. (K2)

UNIT I STATICS OF PARTICLES – EQUIVALENT SYSTEMS OF FORCES 9

Laws of Mechanics – Single equivalent force – Equilibrium of a particle - Vectorial representation of forces – Forces in space – Equilibrium of a particle in space – Principle of transmissibility – Equivalent forces – Moments and Couples – Moment of a force about a point - Scalar components of a moment.

UNIT II PROPERTIES OF SURFACES 9

First moment of area of simple sections from integration – Second moment of simple plane area –Parallel axis theorem and perpendicular axis theorem - Polar moment of inertia.

UNIT III EQUILIBRIUM OF RIGID BODIES 9

Free body diagram – Types of supports and their reactions – Equilibrium of Rigid bodies in two dimensions – point loads, UDL and UVL on beams, shear force and bending moment in beams, analysis of cantilevers and simply supported beams - shear force and bending moment diagrams.

UNIT IV FRICTION 9

Frictional force -Laws of Coulomb friction -Simple contact friction – Angle of Repose; Angle of friction - Coefficient of friction – Problems involving dry friction – Ladder friction - Rolling resistance – Belt friction.

UNIT V ELEMENTS OF RIGID BODY DYNAMICS 9

Kinematics of rigid bodies: Dentition and motion of a rigid body; Translation and Rotation of Rigid Bodies - Angular velocity of a rigid body, and its rate of change – General Plane motion – Absolute and relative motion method of analysis.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Hibbeller RC, “Engineering Mechanics: Statics & Dynamics”, 13th Edition, Pearson India Education Services Private Limited, 2012.
2. Beer FP, Mazurek DF, Sanghi S, Eisenberg ER, Johnston ER and Cornwell PJ, “Vector Mechanics for Engineers: Statics and Dynamics”, 10th Edition, Tata Mc-Graw Hill Education Private Limited, 2012.

REFERENCES

1. L. Meriam and L. G. Kraige, “Engineering Mechanics: Statics & Dynamics”, Wiley, 2011.
2. Rajasekaran S and Sankarasubramanian G, “Fundamentals of Engineering Mechanics”, 3rd Edition, Vikas Publishing House Private Limited, 2010.
3. Irving H Shames, “Engineering Mechanics – Statics and Dynamics”, 4th Edition, Pearson Education Asia Private Limited, 2003.

4. Ashok Gupta, "Interactive Engineering Mechanics–Statics – A Virtual Tutor (CDROM)", Pearson Education Asia Private Limited, 2002.
5. Palanichamy MS and Nagan S, "Engineering Mechanics – Statics and Dynamics", 3rd Edition, Tata McGraw Hill, 2004.

19MC01C ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C
3 0 0 0

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO 1: explain the structure and function of ecosystem. (K2)
CO 2: recognize the values of biodiversity and natural resources and the ways to protect the biodiversity of his /her locality. (K2)
CO 3: explain the causes and effects of pollution. (K2)
CO 4: describe social issues related to the environment and the environment act. (K2)
CO 5: identify the nutrients in food and impact of metals on human health. (K2)

UNIT I ENVIRONMENT AND ECOSYSTEMS 9

Scope and importance of environment – need for public awareness – ecosystem – structure and function of an ecosystem – energy flow in the ecosystem – forest and aquatic ecosystems – Field study of simple ecosystems – pond and forest.

UNIT II BIODIVERSITY AND NATURAL RESOURCES 9

Biodiversity: genetic, species and ecosystem diversity – threats to biodiversity – endangered and endemic species in India – conservation of biodiversity; forest resources: use and over-exploitation – deforestation – water resources: use and overutilization of surface and ground water – role of an individual in conservation of natural resources.

UNIT III ENVIRONMENTAL POLLUTION 9

Causes, effects and control measures of air pollution, water pollution, noise pollution and nuclear hazards – e-waste – toxic substances in e-waste – risks related to toxic substances – role of an individual in prevention of pollution.

UNIT IV SOCIAL ISSUES, HUMAN POPULATION AND ENVIRONMENTAL LAW 9

Water conservation – rain water harvesting – climate change – global warming, acid rain, ozone layer depletion – population growth – population explosion – family welfare programme; Environment laws: environmental (protection) act 1986-the wild life (protection) act 1972.

UNIT V FOOD AND HUMAN HEALTH 9

Carbohydrates, lipids and vitamins in balanced diet food; disease caused by deficiency of carbohydrates, amino acids, proteins, lipids and vitamins - food adulteration - simple test for food adulterants; environmental toxicology: metals in environment- impacts of lead, cadmium, mercury and chromium on human health.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Miller G. and Spoolman S, "Environmental Science", 14th Edition, Brooks/Cole Publishing Co., 2012.
2. Maczulak A.E., "Environmental Engineering", Facts on file Inc., 2009
3. Han D, "Concise Environmental Engineering", PhD & Ventus Publishing ApS, 2012

REFERENCE

1. Weller K. "Environmental Science and Biological Engineering", 1st Edition, WIT Press, 2015 2. Strange C. "Environmental Science and production" NasonTrest Publisher, 2010

19EE37C ANALOG ELECTRONICS LABORATORY L T P C
0 0 3 1.5

COURSE OUTCOMES

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

CO1: Design the different Transistor Biasing Circuits and amplifiers (K2).
CO2: Demonstrate the basic applications of operational amplifier (K2).
CO3: Design the applications of special ICs and power supply circuits (K3).

LIST OF EXPERIMENTS

1. Frequency response of Common Emitter Amplifier.
2. Design of MOSFET based amplifier
3. Half wave and Full wave Rectifiers with filters
4. Voltage regulators
5. Design and implementation of power amplifiers
6. Characteristics of MOSFET
7. Characteristics of BJT as CB and CE configuration
8. Timer IC application: Astable and Monostable operation.
9. Application of Op–Amp: Inverting and Non–inverting amplifier, Voltage follower, Comparator
10. Application of Op–Amp: P, PI, PID controller and Active filters
11. Analog to Digital Converter and Digital to Analog Converter
12. Design of Zener Voltage regulator and variable power supply.

P: 45; TOTAL: 45 PERIODS

19EE38C ELECTRICAL MACHINES – I LABORATORY L T P C
0 0 3 1.5

COURSE OUTCOMES

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

CO 1: understand the concepts of starters and speed control of DC motor (K2)
CO 2: analyze the performance of DC generators (K2)
CO 3: appraise the characteristics of DC motors (K2)
CO 4: experiment the principle of transformers (K2)
CO 5: identify the losses and efficiency of Transformer and DC machines (K2)

LIST OF EXPERIMENTS

1. External and Internal characteristic of DC Generators (Shunt, Series and Compound).
2. Load Characteristics of D.C. Motor. (Shunt and Series)
3. Speed Control of DC shunt motors
4. Swinburne's Test.
5. Hopkinson's Test
6. Load Test on Single Phase Transformer.
7. Separation of No load Losses in Transformer.
8. Sumpner's Test on Single Phase Transformer.
9. Three phase Transformer Connections.(Phase Groups)
10. O.C. / S.C. Test on single Phase Transformer.
11. Study of Starters

P: 45; TOTAL: 45 PERIODS

19EE41C COMPLEX ANALYSIS, NUMERICAL METHODS AND MATHEMATICAL LOGIC **L T P C 2 1 0 3**

COURSE OUTCOMES

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

CO1: Grasp the concepts of analytic functions (K2)
CO2: Evaluate complex integration over contour (K3)
CO3: Use numerical techniques to solve algebraic equation and interpolate (K3)
CO4: Solve differential equations using numerical methods (K3)
CO5: Verify the validity of the arguments (K2)

UNIT I ANALYTIC FUNCTIONS 9

Analytic functions–Necessary and Sufficient conditions Harmonic and orthogonal properties of analytic functions –Harmonic conjugate –Construction of analytic functions – Conformal mapping: w= z+c, cz, 1/z and bilinear transformation.

UNIT II COMPLEX INTEGRATION 9

Cauchy's integral theorem and Cauchy's integral formula – Singular points – Residues – Residue theorem – Application of residue theorem to evaluate real integrals – Unit circle and semi-circular contour excluding poles on boundaries.

UNIT III SOLUTION OF ALGEBRAIC EQUATIONS AND INTERPOLATION 9

Solving non-linear algebraic equations–Newton - Raphson method; Iterative methods – Gauss-Jacobi and Gauss-Seidel methods; Interpolation–Lagrange's and Newton's divided difference formulas –Newton's forward and backward difference formulas.

UNIT IV NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS 9

Taylor's series method – Euler's method –Modified Euler's method – Fourth order Runge - Kutta method – Finite difference methods for solving second order equations –Solution of two dimensional Laplace and Poisson equations.

UNIT V MATHEMATICAL LOGIC 9

Propositional Logic –Equivalences and Implications – Rules of inference – Introduction to proofs – Proof methods and strategy.

L: 30; T: 15; TOTAL: 45 PERIODS

TEXT BOOKS

1. Grewal.B.S "Higher Engineering Mathematics", 44th Edition, Khanna Publications, Delhi, 2017.
2. Grewal, B.S and Grewal,J.S, "Numerical methods in Engineering and Science", 9th Edition, Khanna publishers, New Delhi, 2007.

REFERENCES

1. Trembly J.P and Manohar.R,"Discrete Mathematical Structures with Applications to Computer Science", Tata Mc-Graw Hill Private Limited, New Delhi, 35th Reprint 2008.
2. Ramana B.V,"Higher Engineering Mathematics",6th Edition, Tata Mc-Graw Hill Private Limited, New Delhi, 2008.
3. Jain M.K, Iyengar S.R.K, Jain R.K., "Numerical Methods for Scientific and Engineering Computation", 6th Edition, New age international (P) Ltd., Publishers, Reprint 2012.
4. Kenneth H.Rosen, "Discrete Mathematics and its Applications", 7th Edition, Tata McGraw-Hill Private Limited, New Delhi, Special Indian Edition, 2011.

19EE42C DIGITAL ELECTRONICS L T P C

3 0 0 3

COURSE OUTCOMES

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

CO1: Simplify Boolean functions, design and implement combinational logic circuits. (K2)

CO2: Design and implement sequential logic circuits. (K3)

CO3: Understand the process of Analog to Digital conversion and Digital to Analog conversion. (K2)

CO4: Summarize the characteristics and function of logic families, devices and memories. (K2)

CO5: Write VHDL program for logic circuits. (K2)

UNIT I BOOLEAN ALGEBRA AND COMBINATIONAL CIRCUITS 9

Digital signals, Digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, number systems - binary, signed binary, octal, hexadecimal number, binary arithmetic, one's and two's complements arithmetic, simplification of logic functions using K-map and Quine McCluskey method — Design of combinational circuits: Adders, Subtractors, Multiplexer, De-Multiplexer, Encoder, Decoder, serial adder, digital comparator, parity checker/generator, code converters, Parity checker/generator.

UNIT II ANALYSIS AND DESIGN OF SEQUENTIAL CIRCUITS 9

A 1-bit memory, the circuit properties of Bi stable latch, the clocked SR flip flop, JK, T and D type flip flops, Realization of flip flops, Triggering methods, applications of flip flops, shift registers and its types, sequence generator, design of synchronous counter, asynchronous counter, Analysis of synchronous and asynchronous circuits, special counter IC's.

UNIT III A/D AND D/A CONVERTERS 9

Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications, sample and hold circuit, analog to digital converters: Specifications, quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion- Recent converters(qualitative).

UNIT IV LOGIC FAMILIES, MEMORIES AND PROGRAMMABLE LOGIC DEIVCES 9

Characteristics of digital ICs –Digital logic families: TTL, ECL, NMOS, CMOS – Memory organization and operation, expanding memory size, classification and characteristics of memories, read only memory (ROM), read and write memory(RAM), PROM, EPROM, EEPROM, Flash-Memory size calculation- content addressable memory (CAM), charge coupled device memory (CCD), ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).

UNIT V HARD WARE PROGRAMMING LANGUAGE 9

RTL Design – Behavior, Data flow and Structural modeling – Data Types – Operators – Packages – VHDL programs (using three approaches) for adder, subtractor, multiplexer, de-multiplexer, encoder, decoder, code converter, flip flops, counters.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Morris Mano. M, "Digital Design: with an Introduction to the Verilog HDL", 5th Edition, Pearson Education, 2014.
2. Donald P. Leach, Albert Paul Malvino, Goutam Sha, "Digital Principles and Applications", 7th Edition, Tata Mc-Graw Hill Private Limited, 2011.
3. Jayaram Bhasker, "VHDL Primer", Prentice Hall, 2007

REFERENCES

1. Floyd and Jain, "Digital Fundamentals", 11th Edition, Pearson Education, 2017.
2. Salivahanan. S and Arivazhagan. S, "Digital Circuits and Design", 4th Edition, Vikas Publishing House Private Limited, 2012.
3. Charles H. Roth, "Fundamentals Logic Design", 7th Edition, Jaico Publishing House, 2013.
4. John F. Wakerly, "Digital Design Principles and Practice", 4th Edition, Pearson Education, 2005
5. Ronald J. Tocci, "Digital Systems: Principles and applications", 11th Edition, Pearson Education, 2010.
6. Raj Kamal, "Digital systems –Principles and Design", 2nd Edition, Pearson Education, 2014.

19EE43C **ELECTRICAL MACHINES – II** **L T P C**
3 0 0 3

COURSE OUTCOMES

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

CO1: Understand the fundamental concepts of AC rotating machines (K2).
CO2: Explain the operation of Induction machines (K2).
CO3: Describe the performance of single phase AC machines and special machines (K2).
CO4: Analyze the performance of ac generators (K2).
CO5: Discuss t he operation of synchronous machines (K2).

UNIT I FUNDAMENTALS OF AC MACHINES 9

Physical arrangement of windings in stator and cylindrical rotor; Slots, Coils, concentrated and distributed winding, 3D visualization of the above winding types- Air-gap MMF distribution with fixed current through windings , winding distribution factor, Constant and pulsating magnetic field, alternating current in windings with spatial displacement, Magnetic field produced by a single winding with fixed current and alternating current, Magnetic fields produced by 90 degrees spatially displaced windings, three windings spatially shifted by 120 degrees (revolving magnetic field).

UNIT II THREE PHASE INDUCTION MACHINES 9

Construction, Types (squirrel cage and slip-ring), Torque-Slip Characteristics, Starting and Maximum Torque. No load and Blocked Rotor tests, Equivalent circuit, Phasor Diagram, Circle Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines.

UNIT III SINGLE-PHASE INDUCTION MOTORS AND SPECIAL MACHINES 9

Constructional features double revolving field theory, equivalent circuit, and determination of Parameters, performance analysis. Split-phase starting methods and applications, Special machines: Universal Motor, Reluctance motor, Repulsion motor, Hysteresis motor, Stepper motor and AC series motor.

UNIT IV SYNCHRONOUS GENERATOR 9

Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation – EMF, MMF,ZPF and ASA methods. Operating characteristics of synchronous machines. Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators.

UNIT V SYNCHRONOUS MOTOR 9

Principle of operation – Current loci for constant power input, constant excitation and constant power developed- Power and Torque Equations- Starting methods - V Curves and inverted V curves – Operation on infinite bus bars- Hunting- Synchronous Condensers.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. I. J. Nagrath and D. P. Kothari, “Electric Machines”, Mc-Graw Hill Education, 2010.
2. Mehta. V.K and Rohit Mehta, “Principle of Electrical Machines”, S. Chand Publishers, 2009.

REFERENCES

1. E. Fitzgerald and C. Kingsley, "Electric Machinery”, Tata Mc Graw Hill Education, 2013.
2. M. G. Say, “Performance and design of AC machines”, CBS Publishers, 2002.
3. P. S. Bimbhra, “Electrical Machinery”, Khanna Publishers, 2011.
4. Theraja. B.L, Theraja. A.K, “A text book on Electrical Technology”, Volume–II, S. Chand Company and Ltd, 2009.
5. P.C.Sen, “Principles of Electric Machines and Power Electronics”, John Wiley & Sons, 2007.

19EE44C MEASUREMENT AND INSTRUMENTATION L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: Perform statistical data analysis and infer characteristics of instruments. (K3)
CO2: Describe the operation of various measuring instruments. (K2)
CO3: Design of DC and AC bridges for measuring passive elements. (K2)
CO4: Select transducers for an application and calibrate the instruments to standards. (K2)
CO5: Explain significance of the computer based data acquisition and digital equipments. (K2)

UNIT I STATISTICAL DATA & ERROR ANALYSIS 9

SI units – Static and Dynamic characteristics of instruments - Types of error - Error analysis – Statistical analysis: Mean, Standard deviation – Variance - Probability of errors - Integral error: ISE, IAE analysis- Standard and Calibration.

UNIT II OPERATION OF MEASURING INSTRUMENTS 9

Fundamental elements of an instrument - Types of analog meters – Principle of Moving coil instruments – Moving iron instruments – Extension of meter range – Induction type wattmeter and energy meters – Instrument transformer - Optical CT-CVT-IVT –Rogowski-Hall sensors.

UNIT III AC AND DC BRIDGES 9

Resistance measurement – Wheatstone bridge, Kelvin double bridge – Measurement of earth resistance, insulation resistance – Megger – Measurement of inductance and capacitance – Maxwell’s bridge, Anderson bridge, Desauty’s bridge and Schering bridge.

UNIT IV TRANSDUCER 9

Transducers selection - Types – Resistive transducer: Potentiometer - Strain gauge – Inductive transducer: LVDT – Capacitive transducer - Measurement of pressure – Piezo-electric transducers – Measurement of temperature: RTD, thermistor, thermocouple, optical and radiation pyrometers– Encoders.

UNIT V DIGITAL INSTRUMENTATION 9

Quantization - Digital voltmeters, Types – Ramp and integrating – Digital multimeter – Digital storage Oscilloscope – Digital printers and plotters – Data logger: block diagram – LED and LCD displays – LCR meter - Multifunction meter - Smart meter-introduction to virtual instrumentation.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Helfrick, Albert. D and Copper. W.D, 'Electronics Instrumentation and Measurement Techniques', Prentice Hall of India Ltd. & Co, New Delhi, 2010.
2. Doebin. E, 'Measurement Systems: Application and Design', 5th Edition, Tata McGraw Hill, 2006.
3. Sawhney. A.K, 'A Course in Electrical and Electronics – Measurement and Instrumentation', Dhanpal Rai & Sons, New Delhi, 2001.

REFERENCES

1. Kalsi. H.S, 'Electronic Instrumentation', Tata McGraw Hill, 2011.
2. Ernest Frank, Electrical measurement analysis, McGraw Hill, New York
3. Golding and Widdis, Electrical measurements and measuring instruments, Wheeler Publishing House, New Delhi,1993
4. Rangan. C.S, Sharma. G.R and Mani. V.S, 'Instrumentation Devices and Systems', 2nd Edition, Tata McGraw Hill, 2010.
5. John Park Steve Mackay, "Practical Data Acquisition for Instrumentation and Control Systems", 2003.

19EE45C SIGNALS AND SYSTEMS L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: describe the types and properties of different signals and systems (K2).
CO2: appraise the behavior of CT and DT LTI systems with different mathematical approaches (K2).
CO3: analyze signals and systems in complex frequency domain (K2).
CO4: explain the concept of sampling and applications of signals and systems (K2).

UNIT I INTRODUCTION 9

Signals: Types – Properties: periodicity, absolute integrability, determinism and stochastic character – Basic Signals: unit impulse, unit step, sinusoid, complex exponential and time-limited signals - continuous and discrete time signals.

Systems: continuous and discrete time systems – Properties: additively and homogeneity, shift-invariance, causality, stability, reliability.

UNIT II BEHAVIOR OF CT AND DT LTI SYSTEMS 9

Impulse response and step response – convolution - input-output behavior - cascade interconnections - Characterization of causality and stability of LTI systems - System representation through differential equations and difference equations – the notion of a frequency response and its relation to the impulse response -State-space Representation of systems - State-Space Analysis.

UNIT III ANALYSIS OF CT SIGNAL AND SYSTEM 9

Fourier series representation of periodic signals - Waveform Symmetries - Calculation of Fourier Coefficients. Fourier Transform - convolution/multiplication and their effect in the frequency domain - magnitude and phase response - Fourier domain duality.

Laplace Transform for continuous time signals and systems - system functions - poles and zeros of system functions and signals - Laplace domain analysis -solution to differential equations and system behavior.

UNIT IV ANALYSIS OF DT SIGNAL AND SYSTEM 9

Discrete-Time Fourier Transform (DTFT) and Discrete Fourier Transform (DFT) - Parseval's Theorem. Z-transform for discrete time signals and systems - system functions - poles and zeros of systems and sequences - z-domain analysis - solution to difference equations and system behavior.

UNIT V APPLICATIONS OF SIGNALS AND SYSTEMS 9

Analog to Digital Conversion - Sampling Theorem and its implications - Spectra of sampled signals – Digital to Analog Conversion – Reconstruction with ideal interpolator, zero-order hold, first-order hold - Aliasing and its effects - Relation between continuous and discrete time systems - modulation for communication, filtering, feedback control systems.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, “Signals and systems”, Prentice Hall India, 1997.
2. J.G.Proakis and D.G.Manolakis, “Digital Signal Processing: Principles, Algorithms, and Applications”, Pearson, 2006.

REFERENCES

1. H. P. Hsu, “Signals and systems”, Schaum’s series, McGraw Hill Education, 2010.
2. S. Haykin and B. V. Veen, “Signals and Systems”, John Wiley and Sons, 2007.
3. A. V. Oppenheim and R. W. Schafer, “Discrete-Time Signal Processing”, Prentice Hall, 2009.
4. M. J. Robert “Fundamentals of Signals and Systems”, McGraw Hill Education, 2007.
5. B. P. Lathi, “Linear Systems and Signals”, Oxford University Press, 2009.

19EE46C **BIOLOGY FOR ENGINEERS** **L T P C**
2 0 0 2

COURSE OUTCOMES

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

CO1: describe and comprehend the fundamental concepts of cell biology. (K2)
CO2: understand the various bimolecular interactions in living organisms. (K2)
CO3: familiar with biological database. (K2)
CO4: understand the thermodynamic concepts in living organisms. (K2)
CO5: apply the molecular modeling methods in the drug design. (K2)

UNIT I CELL BIOLOGY 6

Cell as a basic unit of life-Cell organization of prokaryotic and eukaryotic cells-Structural and functional capitalization of cell: Mitochondria, Chloroplast, Lysosomes, Golgi bodies, Plasma membrane, Cytoskeleton, Cell wall and Nucleus-Cell cycle-cell division: mitosis and meiosis.

UNIT II BIO MOLECULAR INTERACTIONS 6

DNA and RNA-hydrophobicity and hydrophilicity-Molecular interactions: Hydrogen bonding, Hydrogen Bonding Descriptors, vander vaals interaction- partition coefficient: (Log p) octanol -water system -Lipinski's rule

UNIT III METABOLISM 6

Cell metabolism with respect to Carbohydrates and amino acids-Regulation of blood glucose and homeostasis- Glycogenesis and glycogenolysis and their regulation-measurement of blood glucose level.

UNIT IV BIOMATERIALS AND TESTING 6

Degradable Biomaterials: PGA and PLA); Composite Biomaterials: Properties-classification-Applications:fabrication of biodevices and implants. Testing: Physiochemical Test, Mechanical Test, Invitro and Invivo types.

UNIT V BIOSENSORS 6

Introduction – requirements to be better sensor-application-construction and function of Biosensor-classification-Advantages of biosensor; amperometric enzyme electrodes-characteristics- enzyme activity determinations – biosensors for enzyme immunoassay – Potentiometric enzyme electrodes – electrode characteristics and performance- pH glass and ion-selective electrodes – solid-state pH and redox electrodes –gas electrodes.

L: 30; TOTAL: 30 PERIODS

TEXT BOOKS

1. A.Nag and B. Dey , Computer aided drug design and delivery system, McGraw-Hill, ISBN: 978-0-07-170125-9, 2011
2. Philip N. Bartlett, Bioelectro chemistry: Fundamentals, Experimental Techniques and Applications 1st Edition, John Wiley & Sons, 2008
3. Ratner and Hoffmann, Biomaterial Science: An Introduction to Materials in Medicine, 2nd Edition, 2004

4. D.V.Vranken, G.A.Weiss, Introduction to Bioorganic Chemistry and Chemical Biology, CRC, 1st Edition, Taylor & Francis, 2012

REFERENCES

1. Shashi Chawla, A text book of engineering chemistry, 3rd Edition, Dhanpat rai & Co, New Delhi
2. John K Young, Introduction to Cell Biology, World scientific, 2010

19MC02C CONSTITUTION OF INDIA L T P C
3 0 0 0

COURSE OUTCOMES

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

CO1: describe the salient features of the Indian Constitution. (K2)
CO2: discuss the structure and functions of parliament. (K2)
CO3: elaborate the structure and functions of state legislature. (K2)
CO4: explain the fundamentals of organization and working of the Judiciary. (K2)
CO5: discuss the foreign policy of India. (K2)

UNIT I INDIAN CONSTITUTION 9

Salient Features – Preamble - Pillars of constitution - Fundamental Rights – Directive Principles of State Policy - Fundamental Duties.

UNIT II PARLIAMENTARY SYSTEM 9

Powers and Functions of President and Prime Minister - Council of Ministers - The Legislature Structure and Functions of Lok Sabha and Rajya Sabha – Speaker.

UNIT III FEDERAL SYSTEM 9

Features of Federal System - Administrative Relationship between Union and States - Powers and Functions of Governor and Chief Minister – Council of Ministers - State Legislature.

UNIT IV THE JUDICIARY 9

Organization and Composition of Judiciary - Powers and Functions of the Supreme Court - Judicial Review – High Courts.

UNIT V INTERNATIONAL POLITICS 9

Foreign Policy of India – VISA Application Process - International Institutions like UNO, WTO, SAARC and Environmentalism.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Basu D.D," Introduction to Indian Constitution", Prentice Hall of India, New Delhi, 2015.
2. Gupta D.C, "Indian Government and Politics", Vikas Publishing House, New Delhi, 2010.

REFERENCES

1. Pylee M.V, “Introduction to the Constitution of India”, Vikas Publishing House, New Delhi, 2011.
2. Kashyap S, “Our Constitution”, National Book Trust, New Delhi, 2010.
3. Shukla V N, “Constitution of India”, Eastern Book Company Ltd., New Delhi, 2011

19EE47C DIGITAL ELECTRONICS LABORATORY L T P C
0 0 3 1.5

COURSE OUTCOMES

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

CO1: Design and demonstrate the working of combinational circuits. (K2)
CO2: Construct sequential circuits like n –bit modulo counters and shift registers.(K3)
CO3: Design and demonstrate the operation of A/D and D/A converters. (K2)

LIST OF EXPERIMENTS

1. Study of Basic Digital IC’s.
2. Implementation of Boolean Functions and Adder/ Subtractor circuits.
3. Code converters (Binary – Gray, Gray – Binary, BCD – Excess 3)
4. Encoders and Decoders.
5. Multiplexer/ De–multiplexer
6. Magnitude comparator
7. Parity generator and parity checker
8. Flip Flops (SR, JK, D and T)
9. Counters: synchronous and Asynchronous.
10. UP/DOWN counter
11. Shift Registers: SISO, SIPO, PISO, PIPO modes.
12. Analog to Digital Converter and Digital to Analog Converter
13. VHDL coding for simple circuits

P: 45; TOTAL: 45 PERIODS

19EE48C MEASUREMENT AND INSTRUMENTATION LABORATORY L T P C
0 0 3 1.5

COURSE OUTCOMES

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

CO1: Practice statistical data analysis for a set of data to infer characteristics and error in measurement. (K2)
CO2: Design DC and AC bridges and validate using digital meters. (K3)
CO3: Calibrate the instruments and analyze the characteristics various transducers (K2)
CO4: Experiment with DSO and infer the dynamic response of RLC their operational region their limitations. (K3)
CO5: Perform the computer based data acquisition, simulation and coding. (K2)

LIST OF EXPERIMENTS

1. Measure and analysis of Error for a set of data from a batch of resistance

2. Inductance measurement using Anderson bridge and hay's bridge and validate with LCR meter
3. Capacitance measurement using schering bridge and de-saulty bridge and validate with LCR meter
4. Resistance measurement using Kelvin double bridge
5. Insulation resistance measurement using Megger
6. Calibration of LVDT, pressure transducers and strain gauge**.**
7. Design of temperature measuring circuit using thermocouple
8. Calibration of three phase energy meter by two wattmeter method and validate using multifunction meter.
9. Extension range of voltmeter and ammeter.
10. Current measurement using CT and hall effect sensor
11. Practice of signal measurement and transient analysis of RLC circuit using DSO.
12. ELVIS Data acquisition system using LabVIEW platform.
13. C program code development for electrical parameter measurements.
14. Virtual lab exercises.

P: 45; TOTAL: 45 PERIODS

19EE49C ELECTRICAL MACHINES – II LABORATORY L T P C
0 0 3 1.5

COURSE OUTCOMES

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

CO 1: compute the regulation of Three Phase Alternator using various methods (K2).
CO 2: evaluate the performance characteristics of Induction motors (K2).
CO 3: explain the various staring methods of AC motors (K2).
CO 4: predict the performance characteristics of induction motors (K2).
CO5: explain the performance of synchronous motors (K2).

LIST OF EXPERIMENTS

1. Study of AC Motor Starters.
2. Regulation of Three Phase Alternator by EMF method.
3. Regulation of Three Phase Alternator by MMF method.
4. Regulation of Three Phase Alternator by ZPF method.
5. Regulation of Three Phase Alternator by ASA method.
6. Regulation of Three Phase Salient Pole Alternator by Slip test
7. Synchronisation of Alternator with bus bars by dark lamp method.
8. V and Inverted V curves of Three Phase Synchronous Motor.
9. Load test on Three Phase slip ring Induction Motor.
10. Predetermination of performance characteristics of three phase squirrel cage induction motor by circle diagram and equivalent circuit.
11. Separation of No–load losses of Three Phase Induction Motor.
12. Load test on Single Phase Induction Motor.
13. Equivalent Circuit of Single Phase Induction Motor.

P: 45; TOTAL: 45 PERIODS

19EE51C **POWER SYSTEM - I** **L T P C**
3 0 0 3

COURSE OUTCOMES

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

CO 1: Explain the basic concepts of power systems. (K2)
CO 2: Compute the electrical parameters of Transmission line. (K2)
CO 3: Analyze the performance of various Transmission lines. (K2)
CO 4: Evaluate the performance of insulators and cables. (K2)
CO 5: Explain the concepts of substation and mechanical design of overhead line. (K2)

UNIT I BASIC CONCEPTS OF POWER SYSTEMS 9

Evolution of Power Systems and Present-Day Scenario - Structure of a power system: Bulk Power Grids and Micro-grids - Generation: Conventional and Renewable Energy Sources - Distributed Energy Resources - Transmission and Distribution Systems: Meshed and radial systems - Synchronous Grids and Asynchronous (DC) interconnections.

UNIT II TRANSMISSION LINE PARAMETERS 9

Overhead Transmission Lines and Cables: Electrical and Magnetic Fields around conductors - Parameters of single and three phase transmission lines with single and double circuits - stranded and bundled conductors – Skin and proximity effects.

UNIT III PERFORMANCE OF TRANSMISSION LINES 9

Classification of lines – Short, medium and long line – Equivalent circuits, attenuation constant – Phase constant – Transmission efficiency and voltage regulation – Surge impedance loading– Ferranti effect and corona loss.

UNIT IV INSULATORS AND CABLES 9

Insulators-Types, voltage distribution in insulator string, improvement of string efficiency, Underground cables-Types of cables, Parameters of cable, Dielectric stress - Grading of cables, Capacitance of 3-core belted cable.

UNIT V MECHANICAL DESIGN OF OVERHEAD LINES AND SUBSTATION 9

Mechanical design of transmission line - sag and tension calculations for different weather conditions – Towerspotting – Types of towers.

Sub-station Layout (AIS and GIS), Types of substations – Bus-bar arrangements - Methods of grounding.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Wadhwa C.L., “Electric Power Systems”, New Age International (P) Ltd., 6th Edition, 2018.
2. Kothari D.P. and Nagrath I.J., “Power System Engineering”, Tata McGraw Hill Private Limited, New Delhi, 3rd Edition, 2019.
3. Mehta V. K. and Rohit Mehta, “Principles of Power System”, S.Chand Company & Ltd, New Delhi, 2018.

REFERENCES

1. Singh S.N., "Electric Power Generation, Transmission and Distribution", Prentice Hall Private Limited, New Delhi, 2008.
2. J.Grainger and W.D.Stevenson, "Power System Analysis", McGraw Hill Education, 1st Edition, 2017.
3. Hadi Saadat, "Power System Analysis", Tata McGraw Hill Private Limited, 3rd Edition, 2011.
4. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, "Electric Power systems", 5th Edition, Wiley, 2013.

19EE52C CONTROL SYSTEMS L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1 Develop the transfer function model of the physical system. (K3)
CO2: Analyze the time domain behavior of the system. (K3)
CO3: Analyze the frequency domain behavior of the system. (K3)
CO4: Describe the behavior of system using state space representation. (K2)
CO5: Design suitable compensator and controller for a system. (K2)

UNIT I MATHEMATICAL MODELING OF PHYSICAL SYSTEMS 9

Systems - Control System - open and closed loop systems. Frequency domain modeling electrical, mechanical and electro mechanical systems - Transfer function models -Electric Circuit Analogy. Reduction of multiple Subsystems**:** Block Diagram Reduction-Signal Flow Graph.

UNIT II TIME RESPONSE ANALYSIS AND STABILITY 9

Standard test signals - Time response of first and second order systems - Steady State Error - Generalized error series - Characteristic equation - Routh-Hurwitz Criteria- Construction of Root-loci- Effect of addition of poles and Zeros.

UNIT III FREQUENCY RESPONSE ANALYSIS AND STABILITY 9

Frequency response and Frequency domain specifications - Bode Plot - Polar Plot. Closed loop frequency response: M and N circles, Nichol's chart.Stability: Nyquist Stability Criteria – Gain Margin and Phase Margin via bode plots and Nyquist Diagram.

UNIT IV TIME DOMAIN MODELING OF SYSTEMS 9

Concepts of state variables - State Space Representation: State space model from transfer function - Signal Flow Graphs of State equations - Cascade form- Parallel form- Solution of state equations.- Concept of controllability and observability - Stability in state space.

UNIT V COMPENSATOR DESIGN AND CONTROLLER TUNING 9

Controller and its classification - PID Controller - PID tuning using Ziegler-Nichols technique - State Feedback controller using pole placement - Design of Lag compensator, Lead Compensator and Lag-Lead Compensator using Bode plot.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Nagrath I.J and Gopal M., "Control Systems Engineering", New Age International Publishers, 5th Edition (Reprint), 2016.
2. Norman S. Nise, Control Systems Engineering, 6th Edition, John Wiley, 2010. (Indian Edition)

REFERENCES

1. Benjamin C. Kuo, "Automatic Control systems", PHI Learning Private Ltd, Jan 2014.
2. K. Ogata, "Modern Control Engineering", 5th Edition, Prentice Hall Private Limited, New Delhi, 2010.
3. Richard.C. Dorf and Robert H. Bishop, "Modern Control Systems", Addison –Wesley, Oct, 2013.
4. Gopal M., "Control Systems: Principles and Design", 4th Edition, Tata Mc-Graw Hill Private Limited, New Delhi, 2012.

19EE53C MICROPROCESSOR AND MICROCONTROLLER L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: illustrate the architecture of Microprocessors (8085/8086). (K2)
CO2: write programs based on the instruction sets of 8085 Microprocessor. (K2)
CO3: illustrate the architecture of 8051 Microcontroller. (K2)
CO4: write programs based on the instruction sets of 8051 Microcontroller. (K2)
CO5: develop application circuits by programming towards simple project development. (K2)

UNIT I INTRODUCTION TO 8 AND 16 BIT PROCESSORS 9

Introduction – 8085 Microprocessor: Architecture, Pin outs and signals, Instruction set and addressing modes - Timing diagram, Memory interfacing, Interrupt structure – I/O ports and data transfer concepts - 8086 processor (Architecture and modes of operation only).

UNIT II PROGRAMMING AND INTERFACING OF 8085 MICROPROCESSOR 9

Arithmetic programs using 8085 – Loop structure with counting & Indexing - Delay calculation with single and more loops – Lookup table - Interfacing – Peripheral IC's: 8255 Programmable Peripheral interface architecture and modes of operation, Interfacing ADC, DAC and traffic light ,PID Controller, with 8085 through 8255.

UNIT III 8051 MICROCONTROLLER 9

Overview of the 8051 family – Architecture: CPU, ALU, address, data and control bus, Working registers, SFRs, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Data and Program Memory - Timer -I/O port structure – Interrupt structure - Comparison of 8-bit microcontrollers, 16-bit and 32-bit microcontrollers. Definition of embedded system and its characteristics, Role of microcontrollers in embedded Systems.

UNIT IV 8051 INSTRUCTION SET AND PROGRAMMING 9

Addressing modes: Introduction, Instruction syntax, Data types, Subroutines Immediate addressing, Register addressing, Direct addressing, Indirect addressing, Relative addressing, Indexed addressing, Bit inherent addressing, bit direct addressing - 8051 Instruction set: Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Subroutine instructions, Bit manipulation instructions - Assembly language programs, C language programs, Programming and debugging tools.

UNIT V APPLICATIONS OF 8051 MICROCONTROLLER 9

Interfacing external memory Devices, Analog to Digital Converter, Digital to Analog Converter, LED, LCD, Keyboard, Stepper motor,DC Motor and Sensor. Synchronous and Asynchronous Communication. RS232, SPI, I^2C. Introduction and interfacing to protocol like Blue-tooth.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Senthilkumar N., Saravanan M. and Jeevananthan.S, "Microprocessor and Microcontrollers", Oxford University Press, Aug 2016.
2. Krishna Kant "Microprocessor and Microcontrollers", Eastern Company Edition, Prentice Hall Private Limited, New Delhi, Jan 2013.

REFERENCES

1. M. A.Mazidi, J. G. Mazidi and R. D. McKinlay, "The 8051Microcontroller and Embedded Systems: Using Assembly and C", Pearson Education, 2007.
2. K. J. Ayala, "8051 Microcontroller", Delmar Cengage Learning, 2004.
3. R. Kamal, "Embedded System", McGraw Hill Education, 2009.
4. R. S. Gaonkar, ", Microprocessor Architecture: Programming and Applications with the 8085", Penram International Publishing, 1996
5. D.A. Patterson and J.H. Hennessy, "Computer Organization and Design: The Hardware/Software interface", Morgan Kaufman Publishers, 2013.
6. D. V. Hall, "Microprocessors & Interfacing", McGraw Hill Higher Education, 1991. PCC-EE19: Microprocessor Laboratory (0:0:2 – 1 credit) Hands-on experiments related to the course contents of EE18.

19EE54C HIGH VOLTAGE ENGINEERING L T P C
3 0 0 3

COURSE OUTCOMES

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

CO 1: explain the over voltage phenomenon in electrical Power systems. (K2)
CO 2: describe the various breakdown mechanisms of different dielectrics. (K2)
CO 3: recognize the appropriate methods for high voltage and current generation. (K2)
CO 4: extend the measurement principles to figure the values of high voltage and current. (K2)
CO 5: outline of necessity and methods of testing the various apparatus in HV Lab. (K2)

UNIT I LIGHTNING AND SWITCHING OVERVOLTAGES 9

Lightning overvoltage: Charge formation in clouds, Stepped leader, Dart leader, Lightning Surges– Switching overvoltage: Causes of surges and its effects on power system – Protection against overvoltage – Surge diverters – Surge modifiers – Estimation of Overvoltages – Reflection and Refraction of Travelling waves - Insulation Coordination.

UNIT II DIELECTRICS AND BREAKDOWN MECHANISM 9

Properties of Dielectrics - Gaseous breakdown in uniform and non-uniform fields - Townsend's Theory – Streamer Mechanism – Corona discharges – Vacuum breakdown - Conduction and breakdown in pure and commercial liquids – Breakdown mechanisms in solid and composite dielectrics – Partial Discharges – Applications and Maintenance of Dielectrics.

UNIT III GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS 9

Generation of high D. C. and A.C. voltages – Generation of impulse voltages – Generation of impulse currents – Tripping and control of impulse generators.

UNIT IV MEASUREMENTS OF HIGH VOLTAGES AND CURRENTS 9

Peak voltage, impulse voltage and high direct current measurement methods – Cathode ray oscillographs for impulse voltage and current measurement – Measurement of dielectric constant and loss factor - Partial discharge measurements - Digital Measurement Techniques.

UNIT V HIGH VOLTAGE TESTING AND HIGH VOLTAGE LABORATORIES 9

High voltage testing of electrical power apparatus as per International and Indian standards – Power frequency, impulse voltage and DC testing of Insulators, bushing, isolators, circuit breakers and transformers– High voltage laboratory layout– Indoor and outdoor laboratories– Testing facility requirements – Safety precautions in H.V. Labs.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. M. S. Naidu and V. Kamaraju, "High Voltage Engineering", 5th Edition, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2013.
2. E.Kuffel and W.S. Zaengl, J.Kuffel, "High voltage Engineering Fundamentals", Newness, 2nd Edition, Elsevier, New Delhi, 2005.

REFERENCES

1. Rakosh Das Begamudre, "High Voltage Engineering, Problems and Solutions", New Age International Publishers, New Delhi, 2010
2. Hugh M. Ryan, "High Voltage Engineering and Testing", 2nd Edition, The Institution of Electrical Engineers, London, United Kingdom, 2001.
3. Various IS standard for HV Laboratory Techniques and Testing.
4. L.L.Alston, "High Voltage Technology", Oxford University Press, 1st Indian Edition, 2011.
5. C.L.Wadhwa, "High Voltage Engineering", New Age International Publishers, 3rd Edition, 2010.

6. Mazen Abdel Salam, Hussein Anis, Ahdab A-Morshedy and Roshday Radwan, "High Voltage Engineering –Theory &Practice", 2nd Edition, Marcel Dekker, Inc., 2010.
7. Subir Ray, "An Introduction to High Voltage Engineering", 2nd Edition, PHI Learning Private Limited, New Delhi, 2011.
8. M. Khalifa, "High Voltage Engineering-Theory and Practice", Marcel Dekker, Inc. New York and Basel, 1990.
9. Dieter Kind and Kurt Feser, "High Voltage Test Techniques", Reed Educational and Professional Publishing Ltd. (Indian Edition), New Delhi, 2001.

19EE55C OBJECT ORIENTED PROGRAMMING L T P C
3 0 2 4

COURSE OUTCOMES

Upon Completion of this course, the students will be able to

CO1: identify importance of object oriented programming and difference between structured oriented and object oriented programming features. (K3)

CO2: develop programs using functions and define functions using default, constant, arguments, function overloading (K3)

CO3: adopt appropriate constructor and overloading mechanisms to develop the application (K3)

CO4: understand the role of inheritance, polymorphism, dynamic binding and generic structures in building reusable code (K3)

CO5: use advance features like templates and exception to make programs supporting reusability and sophistication (K3)

UNIT I BASIC CONCEPTS 15

Introduction to OOPs - Headers & Name Spaces - Applications of OOP - Structure of C++ - Program - C++ Basics: Keywords – Constants - Data Types - Dynamic Initialization of Variables - Reference Variables - Operators in C++ - C++ Class Overview: Class Definition – Objects - Class Members - Access Control – Class Scope

UNIT II FUNCTIONS AND MEMORY ALLOCATION 15

Parameter passing methods - static class members - this pointer - Arrays of Objects - Objects as Function Arguments - Default Arguments - Constant Arguments -Inline functions - Function Overloading - Friend Functions - Dynamic memory allocation and deallocation (new and delete)

UNIT III CONSTRUCTORS AND INHERITANCE 15

Constructors, Parameterized Constructors, Multiple Constructors in a Class, Constructors with Default Arguments, Dynamic initialization of Objects, Copy Constructors, Dynamic Constructors, Destructors - Introduction to inheritance - Defining Derived Classes - Single Inheritance - Multiple Inheritance - Multi-Level Inheritance - Hierarchical Inheritance - Hybrid Inheritance -Virtual Base Classes - Abstract Classes - Constructors in Derived Classes.

UNIT IV POLYMORPHISM AND FILES 15

Introduction to pointers - Pointers to Objects - Pointers to Derived Classes - compile time polymorphism - Run time polymorphism - Virtual Functions - Pure Virtual Functions - Virtual Destructors - this Pointer - Operator overloading,-Rules for Operator overloading - overloading of binary and unary operators - Files in C++: File I/O - Unformatted and Binary I/O.

UNIT V TEMPLATES AND EXCEPTION HANDLING 15

Introduction - Class Templates - Class Templates with Multiple Parameters - Function Templates, Function Templates with Multiple Parameters -Member Function Templates - Basics of Exception Handling, Types of exceptions - Exception Handing Mechanism - Throwing and Catching Mechanism -Rethrowing an Exception -Specifying Exceptions.

L: 45; P: 30; TOTAL: 75 PERIODS

TEXT BOOKS

1. Herbert Schildt, "C++: The Complete Reference", 5th Edition, Tata McGraw – Hill Publishers, 2017.
2. Paul Deitel, Harvey Deitel, "C++ How to Program", 8th Edition, Prentice Hall Publisher, 2012.
3. Trivedi, Bhushan "Programming with ANSI C++", 2nd Edition, Oxford University Press _ NASW Press, 2012.

REFERENCES

1. Ira Pohl, "Object Oriented Programming using C++", 2nd Edition, Pearson Education, Reprint 2004.
2. S. B. Lippman, Josee Lajoie, Barbara E. Moo, "C++ Primer", 4th Edition, Pearson Education, 2017.
3. Bjarne Stroustrup, "The C++ Programming language", 3rd Edition, Pearson Education, 2013.

19EE56C CONTROL SYSTEMS LABORATORY L T P C

0 0 3 1.5

COURSE OUTCOMES

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

CO 1: Develop Transfer Function Models for Electro-Mechanical Systems. (K2)

CO 2: Predict the time domain specifications from the time response of the Linear system. (K2)

CO 3: Understand the concept of stability from time and frequency response of the system. (K2)

CO 4: Design suitable compensator and controller for given specifications. (K3)

LIST OF EXPERIMENTS

1. Determination of Transfer function of AC servomotor
2. Mathematical modeling of Field Controlled DC Servomotor
3. Mathematical modeling of Armature Controlled DC Servomotor
4. Time Response Analysis of first order system
5. Time Response Analysis of Second Order System
6. Stability Analysis of linear system using root locus Technique
7. Frequency response analysis by using Bode Plot
8. Design and simulation of PID Controller using Zeigler Nichols Technique
9. Design of compensators using Simulation software package
10. Design of state feedback controller using Pole placement technique
11. Study of Modeling and control of Rotary Inverted Pendulum
12. Study of QBOT 2 – vision based control

P: 45; TOTAL: 45 PERIODS

19EE57C MICRPROCESSOR AND MICROCONTROLLER LABORATORY L T P C
0 0 3 1.5

COURSE OUTCOMES

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

CO1: Develop basic arithmetic operations using microprocessor 8085 and 8051. (K3)
CO2: Apply interfacing techniques that provides solutions to real world problems. (K3)
CO3: Choose appropriate peripheral interfacing devices with 8085 and 8051 for specific applications. (K2)

LIST OF EXPERIMENTS

Assembly language programming using 8085 Microprocessor

1. Simple arithmetic operations
2. Programming with control instructions
3. Interface Experiments:
   - A/D Interfacing.
   - D/A Interfacing.
   - Traffic light controller.
   - Simple experiments using 8255
   - Implementation of PID control algorithm

Assembly Language/ C Programming using 8051 Microcontroller

4. Simple arithmetic operations
5. Programming with control instructions
6. Interface Experiments:
   - A/D Interfacing.
   - D/A Interfacing.
   - Stepper motor

7. Study of microcontroller with FLASH memory.
8. PWM Generation

P: 45; TOTAL: 45 PERIODS

19EE61C POWER SYSTEM – II L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: Analyze a power system in steady state using numerical methods. (K2)
CO2: Compute the fault current for different types of faults. (K2)
CO3: Explain various methods to control the voltage and frequency. (K2)
CO4: Discuss about monitoring and control of a power system. (K2)
CO5: Describe the concepts of stability in a power system. (K2)

UNIT I POWER FLOW ANALYSIS 9

Review of the structure of a Power System and its components - Analysis of Power Flows: Formation of Bus Admittance Matrix - Real and reactive power balance equations at a node - Load and Generator Specifications - Application of numerical methods for solution of nonlinear algebraic equations – Gauss Seidel and Newton - Raphson methods.

UNIT II FAULT ANALYSIS 9

Per-unit System and per-unit calculations - Representation of generators, lines and transformers in sequence networks - Method of Symmetrical Components (positive, negative and zero sequences) - Balanced and Unbalanced Faults - Computation of Fault Currents.

UNIT III CONTROL OF FREQUENCY AND VOLTAGE 9

System load variation and characteristics –Load curve –Reserve requirements – Fundamentals of speed governing mechanism and modeling –Speed-load characteristics – Load sharing – control area, LFC control of single and two area systems –Static and dynamic analysis of uncontrolled and controlled cases.

Generation and absorption of reactive power – Relation between voltage, power and reactive power –Methods of voltage control –Tap changing transformer and OLTC

UNIT IV MONITORING AND CONTROL OF POWER SYSTEM 9

Overview of Energy Control Centre Functions: SCADA systems - Phasor Measurement Units – Wide Area Monitoring Systems –State-estimation - System Security Assessment - Various states of a Power System - Contingency Analysis - Preventive Control and Emergency Control.

UNIT V STABILITY CONSTRAINTS IN SYNCHRONOUS GRIDS 9

Swing Equations of a synchronous machine connected to an infinite bus - Power angle curve - Loss of synchronism in a single-machine infinite bus system following a three-phase fault - Analysis using numerical integration of swing equations using Forward Euler method - Runge-Kutta 4th order methods and Equal Area Criterion method - Impact of stability constraints on Power System Operation.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education, 1st Edition, 1994.
2. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, “Electric Power systems”, 5th Edition, Wiley, 2013.

REFERENCES

1. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education, 2nd Edition, 2017.
2. A. R. Bergen and V. Vittal, “Power System Analysis”, Pearson Education Inc., 2nd Edition, 2002.
3. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill Education, 4th Edition, 2011.

19EE62C POWER ELECTRONICS L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: Understand the differences between signal level and power level devices. (K2)
CO2: Analyze the operation of phase controlled rectifiers. (K2)
CO3: Explain the various topologies of DC–DC Converters. (K2)
CO4: Analyze the operation of voltage source inverters. (K2)
CO5: Discuss the applications of power electronics converters. (K2)

UNIT I POWER SEMI–CONDUCTOR DEVICES 9

Basic structure and characteristics of Diode, Thyristor, Power MOSFET and IGBT – Firing and commutation circuit of SCR– Gate driver circuits- snubber circuit - Interpretation of power device data sheet.

UNIT II PHASE–CONTROLLED RECTIFIERS 9

Single-phase diode rectifiers - Single-phase full-bridge thyristor rectifier with R, RL and RLE load - Three-phase full-bridge thyristor rectifier with R, RL and RLE load - Effect of source inductance -Input current wave shape and power factor.

UNIT III DC TO DC CONVERTERS 9

Elementary chopper with an active switch and diode - Power circuit, analysis and waveforms at steady state, relation between duty ratio and average output voltage of Buck, Boost and Buck-Boost converters - Overview of Isolated Converters.

UNIT IV INVERTERS 9

Power circuit, analysis and waveforms of Single phase and three phase voltage source inverter – PWM techniques –Current source inverter-AC voltage controller

UNIT V APPLICATIONS 9

Uninterrupted power supply topologies-Electric drives-residential and industrial applications - Electric utility applications- High Voltage DC transmission - Renewable energy source - Energy storage

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Rashid M.H., “Power Electronics: Circuits, Devices and Applications”, Pearson Education, Prentice Hall Private Limited, New Delhi, 4th Edition, 2014.
2. Bimbra P.S., “Power Electronics”, Khanna Publishers, 4th Edition, 2012.

REFERENCES

1. Robert W. Erickson and Dragan Maksimovic, “Fundamentals of Power Electronics”, Springer, 2001.
2. Ned Mohan, Tore M. Undeland, William P. Robbins, “Power Electronics: Converters, Applications and Design”, 3rd Edition, John Wiley and sons, 2014.
3. L. Umanand, Power Electronics: Essentials and Applications”, Wiley India, 2014.
4. Singh M. D and Khanchandani K. B., “Power Electronics”, 3rd Edition, Tata McGraw Hill Private Limited, New Delhi, 2008.

19EE63C SWITCHGEAR AND PROTECTION L T P C
3 0 0 3

COURSE OUTCOMES

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

CO 1: Understand the different components of a protection system. (K2)
CO 2: Describe the principles of different types of protective relays. (K2)
CO 3: Understand the protection schemes for different power system components. (K2)
CO 4: Explain the operation and testing methods of Circuit breakers. (K2)
CO5: Understand system protection schemes, and the use of wide-area measurements. (K2)

UNIT I PROTECTIVE RELAYS 9

Principles of Power System Protection - Need for protective systems – Protection Zones – Essential qualities of protection - Components of a protection system.
Basic relay terminology - Classification of protective relays based on technology and their operating principles - Classification of protective schemes - Relay Testing - Technical standards and Specifications of Various Relays(Case Study).

UNIT II STATIC RELAYS AND NUMERICAL PROTECTION 9

Static relays – Phase, Amplitude Comparators – Synthesis of various relays using Static comparators – Block diagram of Numerical relays – Overcurrent protection, transformer differential protection, distant protection of transmission lines.

UNIT III EQUIPMENT AND OVERVOLTAGE PROTECTION SCHEMES 9

Introduction to Overcurrent Protection and overcurrent relay co-ordination - Directional, Distance, Differential protection - Transformer and Generator protection - Bus bar Protection – Generation of Over-voltages - Lightning and Switching Surges- Overvoltage Protection.

UNIT IV CIRCUIT BREAKERS 9

Arc phenomena and arc interruption –DC and AC circuit breaking –Types of circuit breakers –Air, oil, SF6 and vacuum circuit breakers –Comparative merits of different circuit breakers –Testing of circuit breakers –Routine test and type test –Concept of gas insulated substation – Technical Standards and Specifications of Various Circuit Breakers(Case Study).

UNIT V SYSTEM PROTECTION 9

Effect of Power Swings on Distance Relaying - System Protection Schemes - Under-frequency, under-voltage and df/dt relays - Out-of-step protection - Synchro-phasors - Application of Wide-Area Measurement Systems for improving protection systems - Intelligent Electronic Devices (IED) & their application for monitoring & protection – IEC Protocol for Protection equipment - Integration of SCADA.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Badri Ram and D.N. Vishwakarma, “Power System Protection and Switch Gear”, Tata Mc-Graw Hill, 2nd Edition, 2011.

2. Sunil S. Rao, "Protection and Switch Gear", Khanna Publishers 4th Edition, New Delhi, 1992.

REFERENCES

1. B. Ravindranath and N.Chander, "Power System Protection and Switch Gear", New Age International Limited, New Delhi, Reprint 2005.
2. J. L. Blackburn, "Protective Relaying: Principles and Applications", Marcel Dekker, New York, 1987.
3. Y.G Paithankar and S.R Bhide, "Fundamentals of power system protection", Prentice Hall of India, 2013.
4. A.G.Phadke and J. S. Thorp, "Synchronized Phasor Measurements and their Applications", Springer US, 2010
5. T.S. Madhava Rao, "Digital / Numerical Relays", Tata McGraw Hill, 1st Edition, 2005.

19EE64C POWER SYSTEM SIMULATION AND HIGH VOLTAGE LABORATORY

L T P C
0 0 2 1

COURSE OUTCOMES

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

CO1: determine the various parameters of power system. (K2)
CO2: compute the parameters for different type of faults in power system network. (K2)
CO3: determine breakdown strength of gaseous dielectric and liquid dielectric. (K2)
CO4: demonstrate the generation methods of High voltage AC, DC and Impulse. (K2)
CO5: infer the field distribution simulation model of single and multiple dielectrics. (K2)

LIST OF EXPERIMENTS

1. Computation of Parameters and Modelling of Transmission Lines
2. Formation of Bus Admittance and Impedance Matrices and Solution of Networks
3. Load Flow Analysis: Solution of Load Flow and Related Problems Using Gauss–Seidel and Newton–Raphson Methods
4. Symmetrical and unsymmetrical Fault Analysis
5. Transient stability analysis of single machine infinite bus system (SMIB).
6. Load –Frequency Dynamics of Single–Area and Two–Area Power Systems
7. Generation and measurement of AC, DC and Impulse voltage
8. Measurement of AC and DC breakdown strength of air under different electrode configurations
9. Measurement of dielectric strength of liquid dielectric
10. Computation of field distribution of parallel plate capacitor with single and multiple dielectrics using FEM. (Analysis)
11. Generation of Lightning and Switching Impulse voltages using circuit simulation package

P: 30; TOTAL: 30 PERIODS

19EE65C POWER ELECTRONICS LABORATORY L T P C
0 0 3 1.5

COURSE OUTCOMES

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

CO1: Illustrate the characteristics of various power semiconductor devices. (K2)
CO2: Evaluate the performance of AC-DC converters. (K2)
CO3: Analyze the basic topologies of DC–DC converters. (K2)
CO4: Make use of different PWM techniques for inverters. (K2)
CO5: Demonstrate the operation of AC voltage controller and Cycloconverter. (K2)

LIST OF EXPERIMENTS

1. Characteristics of SCR and TRIAC
2. Characteristics of MOSFET and IGBT
3. Gate firing circuits for SCR
4. AC to DC fully controlled converter
5. AC to DC half controlled converter
6. MOSFET based Buck and boost converter
7. IGBT based PWM inverter
8. AC Voltage Controller
9. Simulation of Power converters.

P: 45; TOTAL: 45 PERIODS

19EE66C ELECTRONICS DESIGN LABORATORY L T P C
1 0 4 3

COURSE OUTCOMES

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

CO1: Understand the practical issues related to practical implementation of applications using electronic circuits (K2)
CO2: Choose appropriate components, software and hardware platforms. (K2)
CO3: Design a Printed Circuit Board, get it made and populate/solder it with components. (K3)
CO4: Work as a team with other students to implement an application. (K3)

LIST OF EXPERIMENTS

1 Concept of Measuring Instruments – Testing of Meters, AFO, CRO and Components
2 Measurements of AC/DC – voltage, current, rise time, THD and Noise
3 Sensor module design using signal conditioning with analog / digital output
4 Introduction to electronic instrumentation and PC based data Acquisition
5 Analog system design – Applications based on analog IC [NE555, LM741 etc]
6 Interfacing of analog and digital signals with microcontroller
7 Electronic system design employing microcontrollers
8 VLSI programming for CPLD/ FPGAs
9 PCB design and layout using Software

10 Group project involving electronic hardware (Analog, Digital) leading to an application.

L: 15; P: 60; TOTAL: 75 PERIODS

19EE67C PRODUCT DEVELOPMENT LABORATORY L T P C
1 0 2 2

COURSE OUTCOMES

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

CO1: recognize the needs of the customer and select concept to meet the requirements (K4)

CO2: verify the functionality of the concept through prototyping (K4)

UNIT I NEED IDENTIFICATION, TARGET SPECIFICATIONS AND CONCEPT SELECTION 20

Planning-customer need identification through empathy, problem definition, target specifications, concept development and selection.

UNIT II PROTOTYPING AND DEMONSTRATION 25

Prototype development and demonstration - cost estimation - product documentation

L: 15; P: 30; TOTAL: 45 PERIODS

REFERENCES

1. Michael G Luchs, Scott Swan, Abbie Griffin, “Design Thinking: New Product Development Essentials from the PDMA”, Willey, 2015
2. Christian Muller-Roterberg, “Design Thinking”, Wiley Publications, 2021
3. Anita Goyal, Karl T Ulrich, Steven D Eppinger, “Product Design and Development”, Tata Mc Graw Hill Education, 4th Edition, 2011.
4. George E Dieter, Linda C Schmidt, “Engineering Design”, Mc-Graw Hill International Edition, 5th Edition, 2013.
5. Kevin Otto, Kristin Wood, “Product Design”, Indian Reprint, Pearson Education, 2013

Mentor Activities

- Forming multidisciplinary/interdisciplinary batches among the students
- Facilitating the batches to define a problem through empathizing
- Guiding the batches to develop a prototype to verify the functionality of the concept
- Evaluating the students’ activities through demonstration and presentations

End semester Assessments can be made through

- Product demonstration and presentation

Other points

- This course is for all department students
- Course instructor and mentors will be responsible for the academic process.
- In a project batch, maximum number of students shall be limited to four

- Project batch may be interdisciplinary / multidisciplinary
- Multidisciplinary project batches are encouraged and permitted to take mentors from various discipline.

19EE71C PROJECT MANAGEMENT AND FINANCE L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: Explain the concept of operational and project management. (K2)
CO2: Apply the scope of the project to develop the project plan. (K3)
CO3: Relate the technical, business and social environment in the projects. (K3)
CO4: Apply the management principles to form project team successfully. (K3)
CO5: Prepare project schedule using appropriate tools and techniques. (K3)

UNITI BASIC CONCEPT 9

Concept and categories of project - Project development cycle - Concept, tools and techniques of project management - Logistics and supply chain management - Forms of project organizations.

UNIT II PROJECT FORMULATION 9

Project identification, formulation and preparation. Market and demand estimation - Market survey techniques - Demand forecasting. Materials management - Analysis of materials input, technology, production, plant capacity, location and site, civil works, charts, layouts and work schedule. Cost of project - Means of financing, estimates of cost - Financial projections.

UNIT III PROCESS OF PROJECT APPRAISAL 9

Technical, Economic, Financial, Legal and Social appraisal of the Industrial Projects. Problems due to rate of discount, wage-rate, exchange rates, treatment of taxes, social cost-benefits - treatment of risk and uncertainty - sensitivity analysis and probability approach - Single as well as multiple projects.

UNIT IV PROJECT TEAM FORMULATION AND MAXIMIZING PARTICIPATION 9

Project Team frame works - Project Team cultures - Barriers and challenges - Selecting Team Members- Key skills of effective project leaders - Giving / receiving feedback from different members of the project.

UNIT V IMPLEMENTATION, MONITORING AND CONTROL OF PROJECTS 9

Project scheduling, network techniques for resource, cost budgeting and scheduling - Monitoring and post implementation, evaluation of the project – Enterprise Resource Planning (ERP) - Project financing.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Prasanna Chandra, "Projects: Planning, Analysis, Selection, Financing, Implementation and Review", 9th edition, McGraw-Hill, 2019.
2. Maylor "Project Management", 4th Edition, Pearson, 2018.

REFERENCES

1. Clements, J.P. and Gido, C., "Successful Project Management" 7th edition South-Western Cengage Learning, 2018.
2. Gray and Larson, "Project Management: The Managerial Process", 5rd Edition, TMH, 2018.
3. John M. Nicholas, Project Management for Business and Technology - Principles and Practice, Second Edition, Pearson Education,5th Edition 2016.

19EE72C PROJECT WORK – I L T P C
0 0 6 3

COURSE OUTCOMES

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

CO1: identify an innovate or creative idea / concept / solution to a problem (K3)
CO2: perform the detailed literature survey related to concept / idea (K2)
CO3: implement basic prototype to demonstrate the concept (K4)

1. The Project is a theoretical study/analysis / prototype design / modeling and simulation or a combination of these.
2. Should be done as group (preferably four students) project.
3. The progress of the project is evaluated based on a minimum three reviews and final viva-voce examination.
4. A project report is required to be submitted in the standard prescribed format.

P: 45; TOTAL: 45 PERIODS

19EE73C RESEARCH PAPER AND PATENT REVIEW – SEMINAR L T P C
0 0 2 1

COURSE OUTCOMES

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

CO1: understand the emerging technology / research development in the engineering Field (K2)
CO2: acquaint with the concepts published in reputed journals on their area of interest (K2)
CO3: examine patents and procedures available in the data base.(K3)
CO4: effectively communicate the contents to the target audience and handle the questions with confidence (K3)
CO5: Check for patent plagiarism (K2)

The Students will make a technical presentation on current topics related to the specialization. The same will be assessed by a committee appointed by the department.

The students are expected to submit a report at the end of semester covering the various aspects of his/her presentation.

P: 30 TOTAL: 30 PERIODS

19EE74C COMPREHENSION L T P C
0 0 2 1

COURSE OUTCOME

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

CO1: enhance the comprehensive knowledge for attending interviews and competitive exams. (K4)

COURSE CONTENT

The students will review the following subjects to improve their competency level:

GENERAL APTITUDE: Verbal Ability: English grammar, sentence completion, verbal analogies, word groups, instructions, critical reasoning and verbal deduction. Numerical Ability: Numerical computation, numerical estimation, numerical

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigenvalues, Eigenvectors.
Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series, Vector identities, Directional derivatives, Line integral, Surface integral, Volume integral, Stokes's theorem, Gauss's theorem, Green's theorem.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's equation, Euler's equation, Initial and boundary value problems, Partial Differential Equations, Method of separation of variables.

Complex variables: Analytic functions, Cauchy's integral theorem, Cauchy's integral formula, Taylor series, Laurent series, Residue theorem, Solution integrals. Probability and **Statistics:** Sampling theorems, Conditional probability, Mean, Median, Mode, Standard Deviation, Random variables, Discrete and Continuous distributions, Poisson distribution, Normal distribution, Binomial distribution, Correlation analysis, Regression analysis.

Numerical Methods: Solutions of nonlinear algebraic equations, Single and Multi-step methods for differential equations. Transform Theory: Fourier Transform, Laplace Transform, z-Transform.

ELECTRICAL ENGINEERING:

Electric Circuits: Network graph, KCL, KVL, Node and Mesh analysis, Transient response of dc and ac networks, Sinusoidal steady-state analysis, Resonance, Passive filters, Ideal current and voltage sources, Thevenin's theorem, Norton's theorem,

Superposition theorem, Maximum power transfer theorem, Two-port networks, Three phase circuits, Power and power factor in ac circuits.

Electromagnetic Fields: Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss's Law, Divergence, Electric field and potential due to point, line, plane and spherical charge distributions, Effect of dielectric medium, Capacitance of simple configurations, Biot-Savart's law, Ampere's law, Curl, Faraday's law, Lorentz force, Inductance, Magnetomotive force, Reluctance, Magnetic circuits,Self and Mutual inductance of simple configurations

Signals and Systems: Representation of continuous and discrete-time signals, Shifting and scaling operations, Linear Time Invariant and Causal systems, Fourier series representation of continuous periodic signals, Sampling theorem, Applications of Fourier Transform, Laplace Transform and z-Transform.

Electrical Machines: Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three phase transformers: connections, parallel operation; Auto- transformer, Electromechanical energy conversion principles, DC machines: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, starting and speed control of dc motors; Three phase induction motors: principle of operation, types, performance, torque-speed characteristics, no-load and blocked rotor tests, equivalent circuit, starting and speed control; Operating principle of single phase induction motors; Synchronous machines: cylindrical and salient pole machines, performance, regulation and parallel operation of generators, starting of synchronous motor, characteristics; Types of losses and efficiency calculations of electric machines.

Power Systems: Power generation concepts, ac and dc transmission concepts, Models and performance of transmission lines and cables, Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per-unit quantities, Bus admittance matrix, GaussSeidel and Newton-Raphson load flow methods, Voltage and Frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis, Principles of over-current, differential and distance protection; Circuit breakers, System stability concepts, Equal area criterion.

Control Systems: Mathematical modeling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and Steady-state analysis of linear time invariant systems, Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Stability analysis, Lag, Lead and Lead-Lag compensators; P, PI and PID controllers; State space model, State transition matrix.

Electrical and Electronic Measurements: Bridges and Potentiometers, Measurement of voltage, current, power, energy and power factor; Instrument transformers, Digital voltmeters and multimeters, Phase, Time and Frequency measurement; Oscilloscopes, Error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, MOSFET; Simple diode circuits: clipping, clamping, rectifiers; Amplifiers: Biasing, Equivalent circuit and Frequency response; Oscillators and Feedback amplifiers; Operational amplifiers: Characteristics and applications; Simple active filters, VCOs and Timers, Combinational and Sequential logic circuits, Multiplexer, Demultiplexer, Schmitt trigger, Sample and hold circuits, A/D and D/A converters, 8085Microprocessor: Architecture, Programming and Interfacing.

Power Electronics: Characteristics of semiconductor power devices: Diode, Thyristor, Triac, GTO, MOSFET, IGBT; DC to DC conversion: Buck, Boost and Buck-Boost converters; Single and three phase configuration of uncontrolled rectifiers, Line commutated thyristor based converters, Bidirectional ac to dc voltage source converters, Issues of line current harmonics, Power factor, Distortion factor of ac to dc converters, Single phase and three phase inverters, Sinusoidal pulse width modulation.

Programming and Data Structures: Programming in C, C++, Recursion, Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs.

- The staff-coordinator is responsible for scheduling the session plans, monitoring the activities and recording the continual assessments.
- The technical seminars and group discussions will be assisted by subject experts in the department.
- Each student must participate in all the activities and their performance assessment must be recorded.

P: 30 TOTAL: 30 PERIODS

19EE81C	**INTERNSHIP / IN-PLANT TRAINING**	**L T P C**
		0 0 4 2

COURSE OUTCOMES

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

CO1: acquire the knowledge of different industrial / organizational activities (K2)

CO2: document the work and communicate effectively through technical presentation (K2)

1. Student shall undergo internship/in-plant training after getting prior permission from the department
2. A report should be submitted after the successful completion of internship / in-plant training.

P: 60; TOTAL: 60 PERIODS

19EE82C	**PROJECT WORK – II**	**L T P C** **0 0 12 6**

COURSE OUTCOMES

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

CO1: design and develop the working model (K3)

CO2: work independently to complete the project along with team members (K2)

CO3: demonstrate the results and documents the report (K4)

Project work shall be based on any of the following:

1. Fabrication of product/ testing setup of an experimentation unit/ apparatus/ small equipment, in a group.
2. Experimental / Theoretical verification of principles used in the concept.
3. Projects having valid database, data flow, algorithm, and output reports, preferably software based.
4. Research findings, Recommendations and future scope.

P: 180; TOTAL: 180 PERIODS

19EE01E ELECTRICAL MACHINE DESIGN L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: Interpret main dimensions of armature and field systems for D.C. machines. (K2)
CO2: Outline overall Dimensions of single and three phase transformers core, windings and cooling systems for transformers. (K2)
CO3: Interpret main dimensions of squirrel cage and Slip ring induction machines. (K2)
CO4: Illustrate enhanced dimensions of stator of AC machines. (K2)
CO5: Design the basic electrical machines using software tools. (K2)

UNIT I INTRODUCTION 9

Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines.

UNIT II DC MACHINES 9

DC Machines - Output Equations – Main Dimensions and design constraints – Choice of specific loadings – Carter's Coefficient – Net length of Iron – Real & Apparent flux densities-Selection of number of poles – Design of Armature – Design of commutator and brushes- Design of field winding.

UNIT III TRANSFORMERS 9

Output Equations - Sizing of a transformer, main dimensions and design constraints, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers.

UNIT IV INDUCTION MOTORS 9

Output Equations - Sizing of an induction motor, main dimensions and design constraints, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of poly phase machines, magnetizing current, short circuit current, operating characteristics.

UNIT V SYNCHRONOUS MACHINES 9

Output Equations - Sizing of a synchronous machine, main dimensions and design constraints, design of salient pole machines, short circuit ratio, shape of pole face, armature design, estimation of air gap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design, Need for Computer aided Design analysis.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Sawhney A.K. and Chakrabarti A, "A Course in Electrical Machine Design", Dhanpat Rai & Sons, 2016.

2. Say .M.G, "The Performance and Design of Alternating current Machines", CBS Publishers & Distributors, 3rd edition, 2002.
3. S. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing, 2006.

REFERENCES

1. K. L. Narang, "A Text Book of Electrical Engineering Drawings", Satya Prakashan, 2016.
2. A. Shanmuga sundaram, G. Gangadharan and R. Palani, "Electrical Machine Design Data Book", New Age International Pvt. Ltd., 2015.
3. K.M.V.Murthy, "Computer Aided Design of Electrical Machines", B.S. Publications, 2008.
4. Electrical machines and equipment design exercise examples using Ansoft's Maxwell 2D machine design package.

19EE02E ELECTRICAL DRIVES L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: discuss the concepts of multi quadrant dynamics of drives. (K2)
CO2: explain the steady state analyze of fully controlled converter fed separately excited dc drives. (K2)
CO3: design of controller for electrical drives. (K2)
CO4: explain the various speed control strategies of induction motor. (K2)
CO5: describe the various control techniques of synchronous motor. (K2)

UNIT I DRIVE CHARACTERISTICS 9

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, starting & stopping – typical load torque characteristics – Selection of motor.

UNIT II CONVERTER / CHOPPER FED DC DRIVE 9

Steady state analysis of fully controlled converter fed separately excited DC drive – Continuous and discontinuous conduction – Time ratio and current limit control – Four quadrant operation of converter / chopper fed drive.

UNIT III DESIGN OF CONTROLLERS FOR DRIVES 9

Transfer function for DC motor / load and converter – closed loop control with current and speed feedback – armature voltage control and field weakening mode – design of controllers; current controller and speed controller-converter selection and characteristics.

UNIT IV INDUCTION MOTOR DRIVES 9

Stator voltage, frequency, V/f control and Field Weakening - 87 Hz Characteristics - Running in Current Limit – Compensations – Types – Static rotor resistance control– Slip power recovery scheme – Interpretation of VFD datasheet for Fan & Pump Applications.

UNIT V SYNCHRONOUS MOTOR DRIVES 9

V/f control and self control of synchronous motor – Marginal angle control – power factor control – Permanent magnet synchronous motor – Automatic Motor Adaption (AMA) – Motor Heating and Thermal Monitoring – Functional Safety.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Dubey.G.K., "Fundamentals of Electrical drives", Narosa publications, 2010.
2. Bimal K. Bose., “Modern Power Electronics and AC Drives”, Prentice Hall / Pearson Education Private Limited, 2017.

REFERENCES

1. De N. K. and Sen P. K., “Electrical Drives”, Prentice Hall Private Limited, 2012.
2. Murphy J.M.D. and Turnbull, “Thyristor control of AC Motor”, Pergamon Press Oxford, 2014.
3. Krishnan R., “Electric Motor Drives: Modeling, Analysis, and Control”, Wiley, 2014.
4. Gopal K. Dubey, “Power Semi conductor controlled drives”, Prentice Hall Private Limited, 2014.
5. Vedam Subramanyan, “Thyristor control of Electrical Drives”, Tata McGraw Hill Private Limited, 2017.
6. Handbook on Facts Worth Knowing about Frequency Converters, Danfoss Power Electronics, 2014.

19EE03E INDUSTRIAL ELECTRICAL SYSTEMS L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: explain the electrical layout and safety practices (K2)
CO2: discuss the functionalities of various electrical components (K2)
CO3: evaluate the size, rating and cost of electrical installations for residential, and Commercial applications (K3)
CO4: design the illumination systems for residential, commercial, and industrial applications (K3)
CO5: design appropriate electrical system with protective equipments for industrial applications (K3)

UNIT I ELECTRICAL SYSTEM LAYOUT AND SAFETY PRACTICES 9

Electrical system Layout: LT and HT system - Tariff structure - Electric shock and Electrical safety practices – Civilian and Industrial Standards - Indian Energy Exchange Policies – Open Access Power – Sustainable Development Goals (SDG) 7 & 13.

UNIT II ELECTRICAL SYSTEMS COMPONENTS 9

Wiring components - selection of cables - wires, switches, distribution box, net metering system - Protection components - Fuse, Miniature Circuit Breaker (MCB), Molded Case Circuit Breaker (MCCB), Earth Leakage Circuit Breaker (ELCB), Residual Current Circuit Breaker (RCCB) - inverse current characteristics - Single Line Diagram (SLD) of a wiring system, Contactor, Isolator, Relays, Motor Protection Circuit Breaker (MPCB)

UNIT III RESIDENTIAL AND COMMERCIAL ELECTRICAL SYSTEMS 9

Types of residential and commercial wiring systems - general rules and guidelines for installation - load calculation and sizing of wire, rating of main switch, distribution board and protection devices - earthing system calculations - requirements of commercial installation, deciding lighting scheme and number of lamps - earthing of commercial installation - selection and sizing of components.

UNIT IV ILLUMINATION SYSTEMS 9

Introduction - definition and meaning of terms used in illumination engineering - classification of light sources - incandescent lamps, neon lamp, fluorescent lamps, CFL, LED – Smart lighting, design of illumination systems - indoor lighting schemes - factory lighting halls - outdoor lighting schemes - flood lighting - street lighting – decorative lighting – hybrid lighting.

UNIT V INDUSTRIAL SYSTEMS AND COMPONENTS 9

HT connection - industrial substation - Transformer selection - Industrial loads, motors, starting of motors – Diseal Generator - Cable and Switchgear selection - Lightning Protection - Earthing design - Power factor correction – kVAR calculations - type of compensation - Introduction to Power Control Centre(PCC),Motor Control Centre (MCC) panels –Selection and size of UPS and Battery Banks – Panel metering.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. S. L. Uppal and G. C. Garg, “Electrical Wiring, Estimating & Costing”, Khanna publishers, 6th edition (Reprint), 2020.
2. K. B. Raina, “Electrical Design, Estimating & Costing”, New age International, 2018.
3. H. Joshi, “Residential Commercial and Industrial Systems”, McGraw Hill Education, 2016.

REFERENCES

1. S. Singh and R. D. Singh, “Electrical estimating and costing”, Dhanpat Rai and Co., 2018.
2. H.Partab, Art and Science of Utilisation of Electrical Energy”, Dhanpat Rai and Co., New Delhi, 2004.
3. C.L.Wadhwa, “Generation, Distribution and Utilisation of Electrical Energy”, New Age International Pvt. Ltd. 2003.
4. E. O. Taylor, “Utilization of Electric Energy in SI units”, The Orient Blackswan, 2007
5. https://www.iexindia.com/
6. https://www.un.org/sustainabledevelopment/energy/
7. https://www.un.org/sustainabledevelopment/climate-change/
8. W. Fordham-Cooper, “Electrical Safety Engineering”, Butterworth-Heinemann, 3rd Edition, 2013.

19EE07E SWITCHED MODE POWER CONVERSIONS L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: design the magnetics for switched mode power converters. (K3)
CO2: design and analysis of isolated DC-DC converters (K3)
CO3: analyze the non-isolated DC-DC converters. (K2)
CO4: discuss the operation of resonant converters. (K2)
CO5: distinguish various types of UPS and filters. (K2)

UNIT I DESIGN OF MAGNETICS 9

Basic magnetic theory revisions – Inductor design – Design of mutual inductance – Design of transformer for isolated topologies – Ferrite core table and selection of area product – wire table –selection of wire gauge.

UNITII ANALYSIS OF NON-ISOLATED DC-DC CONVERTERS 9

Buck, Boost, Buck- Boost, Cuk and SEPIC converters: Principles of operation – Continuous conduction mode- discontinuous conduction mode – Concepts of volt-sec balance and charge balance – Analysis and design based on steady-state relationships - Performance parameters.

UNIT III ANALYSIS OF ISOLATED DC-DC CONVERTERS 9

Introduction – classification- Forward converter –Flyback converter - Push-pull converter – Half-bridge switching converter – Full-bridge switching converter – Performance parameters.

UNIT IV RESONANT CONVERTERS 9

Classification of resonant converters – Basic resonant circuit concepts – Load resonant converters – Resonant switches converters – zero voltage switching- zero current switching.

UNIT V POWER CONDITIONERS, UPS AND FILTERS 9

Power line disturbances – Power conditioners – Design of UPS, Applications –Voltage filters, Series–parallel resonant filters, filters for PWM VSI, current filter.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Simon S. Ang, “Power Switching Converter”, Marcel Dekker Inc., Taylor and Francis, 3rd Edition, 2010.
2. Umanand L., Bhat S.R., “Design of magnetic components for switched Mode Power converters”, Wiley Eastern Ltd., 2001.

REFERENCES

1. Ned Mohan, Tore M. Undeland, William P. Robbins, “Power Electronics: Converters, Applications and Design”, 3rd Edition, John Wiley and Sons, 2018.
2. Philip T. Krein, “Elements of Power Electronics”, Oxford University Press, 2004.
3. Rashid M.H., “Power Electronics: Circuits, Devices and Applications”, 3rd Edition, Pearson Education, 2017.
4. Keng C. Wu, “Switch–Mode Power Converters: Design and Analysis”, 1st Edition, Academic Press, 2005.
5. Ramanarayanan V., “Course Material on Switched Mode Power Conversion”, IISc Bangalore, 2007.

19EE08E SPECIAL ELECTRICAL MACHINES L T P C

3 0 0 3

COURSE OUTCOMES

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

CO1: analyze given magnetic circuit and understand operation, characteristics and control of PMBLDC motor (K2)

CO2: understand the construction, operation performance characteristics of PMSM and its power controllers. (K2)
CO3: understand the construction, operation and control of SRM drive and its power controllers. (K2)
CO4: understand the construction, operation, characteristics and control of stepper motor. (K2)
CO5: understand the operation & characteristics of other special electrical machines. (K2)

UNIT I PERMANENT MAGNET BRUSHLESS DC MOTORS 9

Fundamentals of Permanent Magnets – Types - Principle of operation - Magnetic circuit analysis - EMF and Torque equations - Characteristics and control

UNIT II PERMANENT MAGNET SYNCHRONOUS MOTORS 9

Construction Features - Principle of operation – EMF and torque equations - Phasor diagram - Power controllers – Characteristics of synchronous reluctance motor - Digital controllers

UNIT III SWITCHED RELUCTANCE MOTORS 9

Constructional features – Principle of operation - Torque prediction – Performance Characteristics - Power converters and controllers – Control of SRM drive - Sensor less operation of SRM – Applications.

UNIT IV STEPPER MOTORS 9

Constructional features – Principle of operation – Types – Torque equation – Linear and Nonlinear analysis – Characteristics – Drive circuits – Closed loop control – Applications.

UNIT V OTHER SPECIAL ELECTRICAL MACHINES 9

PCB Motor- Flux switch machines – Linear induction motor - Synchronous Reluctance Motors - Constructional features – Types – Axial and Radial flux motors - Applications

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. T.J.E. Miller, “Brushless magnet and Reluctance motor drives”, Claredon press, London, 1989.
2. R.Krishnan, “Switched Reluctance motor drives”, CRC presses, 2017.
3. T.Kenjo, “Stepping motors and their microprocessor controls”, Oxford University press, New Delhi, 2017.
4. K.Venkataratnam**, “**Special Electrical Machines”, Universities Press, 2021.
5. Wei Hua, Peng Su, Gan Zhang, Guishu Zhao “Flux-Switching Machines” Wiley Encyclopedia of Electrical and Electronics Engineering, 2015.

REFERENCES

1. T.Kenjo and S.Nagamori, “Permanent magnet and Brushless DC motors”, Clarendon press, London, 1988.
2. R.Krishnan, “Electric motor drives”, Prentice Hall of India, 2015.

3. D.P.Kothari and I.J.Nagrath, “Electric machines”, Tata Mc Graw hill publishing company, New Delhi, Fifth Edition, 2017.
4. Irving L.Kosow, “Electric Machinery and Transformers”, Pearson Education, Second Edition, 2007.
5. Paul Acarnley, "Stepping Motors – A Guide to Motor Theory and Practice", Institution of Engineering and Technology, Fourth Edition, 2002.

19EE10E POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS L T P C
3 0 0 3

COURSE OUTCOMES

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

CO 1: Understand the various Non-Conventional sources of energy (K2)
CO 2: Acquire knowledge on various power converters for Solar energy system. (K2)
CO 3: analyze the Power converter utilized by the wind energy conversion system. (K2)
CO 4: Understand the concepts of grid connection and its issues. (K2)
CO 5: recognize the hybrid operation of wind and PV systems and features of MPPT tracking. (K2)

UNIT I INTRODUCTION TO RENEWABLE ENERGY RESOURCES 9

World and Indian energy scenario - Wind, Solar, Hydro, Geothermal: Availability and Power extraction - Environmental impacts of Renewable energy sources (GHG emission)

UNIT II POWER CONVERTERS FOR SOLAR PV SYSTEM 9

Solar Photovoltaic System – P-V and I-V Characteristics - Power converters for Solar: Line commutated Converter, Buck, boost, buck-boost converters - Interleaved and Multi port converters - Rating of Converter for SPV system– Standalone PV system – Battery Charing- Battery sizing, Array sizing - Charge Controllers

UNIT III POWER CONVERTERS FOR WIND ENERGY SYSTEM 9

Wind Energy Conversion System - Power Converters for Wind: AC voltage Controller - Matrix converter – Bi directional converter- flyback converter - Standalone operation of fixed and variable speed wind energy conversion systems - Static Kramer Drive for DFIG – Static Scherbius using cyclo converter for DFIG – Rotor Resistance Chopper control for WRIG - Rating of Converter for WECS.

UNIT IV GRID CONNECTED SYSTEM 9

Grid interface - Grid connection issues: leakage current, Islanding, harmonics, Active / reactive Power feeding, unbalance Grid Interactive inverter: Line Commuated Inverter – Self Commutated Inverter – Inverter with high frequency Transformer - Selection of inverter – Rating of Inverters for Grid connected System.

UNIT V HYBRID ENERGY SYSTEM 9

Need for hybrid systems- Range and type of Hybrid systems- Case studies of Wind and PV system – PV-Diesel System – Wind-Diesel Hybrid System – Energy Storage Devices for Hybrid Energy System - Maximum Power Point Tracking (MPPT) - MPPT schemes.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Sudipta Chakraborty, Marcelo G. Simes, and William E. Kramer, "Power Electronics for Renewable and Distributed Energy Systems: A Sourcebook of Topologies, Control and Integration", Springer Science & Business, 2013.
2. Nicola Femia, Giovanni Petrone, Giovanni Spagnuolo, Massimo Vitelli, "Power Electronics and control for maximum Energy Harvesting in Photovoltaic Systems", CRC Press, 2013.

REFERENCES

1. Rashid .M. H "Power electronics Hand book", Academic press, 2001.
2. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.
3. Rai. G.D, "Non conventional energy sources", Khanna publishes, 2009.
4. Gray, L. Johnson, "Wind energy system", Prentice Hall INC, 1995.
5. B.H.Khan, "Non-conventional Energy sources", Tata McGraw-Hill Publishing Company, New Delhi, 2017.

19EE14E POWER SYSTEM TRANSIENTS L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: explain the various sources of electromagnetic transient (K2)
CO2: describe the formation and characteristics of travelling waves in transmission line (K2)
CO3: describe the mechanism of over voltages and its effects K2)
CO4: discuss the protection schemes against over voltage (K2)
CO5: evaluate the transient effects in power networks and components (K2)

UNIT I TRANSIENTS IN A TRANSMISSION LINE 9

Travelling waves in transmission line - wave equations for voltage and current - characteristic impedance of transmission line from wave equations - special cases of transmission line - input impedance - standing wave ratio - reflection co-efficient and input power of transmission line - Transmission line as circuit elements.

UNIT II TRAVELLING WAVES ON TRANSMISSION LINE 9

Lumped and Distributed Parameters – Wave Equation – Reflection, Refraction, Behaviour of Travelling waves at the line terminations – Lattice Diagrams – Attenuation and Distortion – Multi-conductor system and Velocity wave.

UNIT III LIGHTNING, SWITCHING AND TEMPORARY OVER VOLTAGES 9

Lightning: Physical phenomena of lightning – Interaction between lightning and power system – Safety measures – Factors contributing to line design – Simple and Abnormal Switching Transients – Transients in three phase circuits – Grounding and Earthing requirements - Earthing Resistance - Very Fast Transient Over voltage (VFTO) – IEC standards and wave models.

UNIT IV PROTECTION AGAINST TRANSIENTS 9

Protection of power systems against transient over-voltage due to switching and lightning - Lightning arrestors - Surge diverter -, Surge capacitors and reactors - Overhead ground wires - Insulation coordination - Computer aids to calculate transient (EMTP).

UNIT V MODELLING OF POWER APPARATUS UNDER TRANSIENT CONDITIONS 9

Introduction - Winding Capacitance - Frequency dependent parameters - Circuit Reduction – Modelling of Lightning and over voltage scenario - Modelling of Transformers, Generators, Motors, Transmission lines, Cables.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Pritindra Chowdhari, “Electromagnetic transients in Power System”, John Wiley and Sons Inc., 2009.
2. L. V. D. Sluis, “Transients in Power Systems”, John Wiley, 2001.

REFERENCES

1. Klaus Ragaller, “Surges in High Voltage Networks”, Plenum Press, New York, 2008.
2. Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering”, New Age International (P) Ltd., New Delhi, Fourth Edition, 2011.
3. Naidu M S and Kamaraju V, “High Voltage Engineering”, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2020.
4. Allan Greenwood, “Electrical Transients in Power System”, Wiley & Sons Inc. New York, 1991.

19EE15E WIND AND SOLAR ENERGY SYSTEMS L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: explain fundamentals and wind turbine concept of wind energy conversion systems. (K2)

CO2: discuss about the fixed and variable speed system and the various generator used in WECS. (K2)

CO3: describe the fundamentals of solar cells. (K2)

CO4: recognize the various solar PV systems and their up gradations along with their benefits. (K2)

CO5: explain the Grid connected Solar and WECS and its controller (K2)

UNIT I INTRODUCTION 9

Components of wind energy conversion system - Wind energy conversion system schemes - Power obtained from wind-simple momentum theory - Power coefficient - Sabinin’s theory-Aerodynamics of Wind turbine - Horizontal axis Wind Turbine (HAWT) – Vertical Axis Wind Turbine (VAWT) - Power developed – Thrust – Efficiency Tip speed ratio.

UNIT II FIXED AND VARIABLE SPEED WEC SYSTEM 9

Generating Systems - Need of variable speed systems - Constant speed constant frequency systems - Choice of Generators - Doubly Fed Induction Generator (DFIG) - Permanent Magnet Induction Generator (PMSG) - Variable speed generators deciding factors - Synchronous Generator - Squirrel Cage Induction Generator.

UNIT III SOLAR ENERGY-BASIC CONCEPTS 9

Introduction - Sun as Source of Energy - Earth, Sun, Earth Radiation Spectrum - Extraterrestrial and Terrestrial Radiations - Spectral Power Distribution of Solar Radiation - Depletion of Solar Radiation.

UNIT IV SOLAR PHOTOVOLTAIC SYSTEMS 9

Introduction - Solar Cell Fundamentals - Solar Cell Characteristics - Solar Cell Classification - Solar Cell Technologies - Solar Cell: Module, and Array Construction - Maximizing the Solar PV Output and Load Matching - Maximum Power Point Tracke - Balance of System Components - Solar PV Systems - Solar PV Applications.

UNIT V GRID CONNECTED SYSTEMS 9

Stand alone and Grid Connected Solar and WECS system-Grid connection Issues - Machine side & Grid side controllers - WECS in various countries - Solar cells to solar array – On–Grid PV system – With and without storage – Off grid stand alone PV system.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Heir S., “Grid Integration of Wind Energy Conversion Systems”, Wiley, 2006.
2. Rai G.D., “Non-conventional Sources of Energy”, Khanna publishers, 2009.
3. Robert Foster, Majid Ghassemi and Alma Cota, “Solar Energy – Renewable Energy and the Environment”, CRC Press, 2009.

REFERENCES

1. Himanshu Tyagi, Prodyut R. Chakraborty, “Solar Energy: Systems, Challenges, and Opportunities (Energy, Environment, and Sustainability)”, Springer, 2020.
2. Freris L.L., “Wind Energy conversion Systems”, Prentice Hall, 1990.
3. Ion Boldea, “Variable speed generators”, Taylor & Francis group, 2006.
4. Golding E.W., “Generation of Electricity by wind power”, Redwood burn Ltd., Trowbridge, 1976.
5. Chetan Singh Solanki, “Solar Photovoltaics Fundamentals, Technologies and Applications”, Prentice Hall Ltd., 2015.
6. James P. Dunlop, “Photovoltaic Systems”, American Technical Publishers, 2009.

19EE16E POWER QUALITY L T P C

3 0 0 3

COURSE OUTCOMES

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

CO 1: explain about various Power quality problems. (K2)

CO 2: explain the importance Transients, Voltage and Current balance (K2)

CO 3: compute Harmonic distortion in the given Electrical drive (K3)
CO 4: analyze the types of power factor improvement methods. (K3)
CO 5: discuss the importance of Custom power devices (K2)

UNIT I INTRODUCTION 9

Power quality - Impact of PQ on end users - Need for PQ monitoring - Various PQ problems: Voltage dips - over voltages - short supply interruptions - voltage fluctuations and flicker.

UNIT II TRANSIENTS, VOLTAGE AND CURRENT UNBALANCE 9

Transient system model - examples of transient models and their response - power system Transient model - types and causes of transients – Lightning - other switching transients. Symmetrical components of currents and voltages – sources – effects - measurements and mitigation.

UNIT III HARMONICS 9

Definition - odd and even harmonics - harmonic phase sequence - voltage and current Harmonics - individual and total harmonic distortion - harmonic standards – sources - effects on various electrical components - measurements and mitigation - passive and active filters (Case Studies).

UNIT IV POWER FACTOR 9

Active and reactive power flow with nonlinear load - displacement and distortion power factor - power factor penalty - power factor improvement - applications of synchronous condensers and static VAR compensators - automatic power factor controller (Case Studies).

UNIT V SOLVING POWER QUALITY PROBLEMS USING CPD 9

Power quality measuring equipment - Smart power quality analyzers - Introduction to Custom Power Devices (CPD) – STATCOM - Dynamic Voltage Restorer (DVR) - Unified Power Quality Controller (UPQC).

L: 45; TOTAL: 45 PERIODS

TEXT BOOK

1. Sankaran C, “Power Quality”, CRC Press (Special Indian Edition) 2009.

REFERENCES

1. Angelo Baggini, “Handbook of Power Quality” John Wiley & Sons Ltd, 2008.
2. Duggan R.C., “Electrical Power Systems Quality”, McGraw-Hill, 2017.
3. Math H.J.Bollen, “Understanding Power Quality Problems: Voltage Sags and Interruptions”, IEEE Press, New York, 2000.
4. Arrillaga.J, Watson.N.R and Chen.S, “Power System Quality Assessment”, John Wiley & Sons Ltd., England, 2000.
5. Bhim Singh, Ambrish Chandra and Kamal Al-Haddad, “Power Quality: Problems and Mitigation Technique”, Wiley Publications, 2015.
6. Arindam Ghosh and Gerald Ledwich, “Power Quality Enhancement Using Custom Power Devices”, Kluwer Academic Publishers, 2002.

19EE18E POWER SYSTEM DYNAMICS AND CONTROL L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: Explain the concepts of power system operation and control. (K2)
CO2: Explain the concept of park's transformation and synchronous machine equation. (K2)
CO3: Model different power system components for the study of stability. (K3)
CO4: Describe the concept of transient, steady state and dynamic stability. (K2)
CO5: Understand the methods to improve stability. (K2)

UNIT I INTRODUCTION TO POWER SYSTEM OPERATIONS 9

Introduction to power system stability – Power system operations and control – stability problems in power system – Impact on power system operations and control.

UNIT II DYNAMIC ANALYSIS AND MODELLING OF SYNCHRONOUS MACHINE 9

Simplest model of the synchronous machine – Equation in physical quantities – Inductance of synchronous machine – Park's transformation to dqo components – assumptions of balanced currents and voltages in the armature – Final machine dynamic equations

UNIT III MODELLING OF POWER SYSTEM COMPONENTS 9

Modelling of transmission lines and loads: Transmission line physical characteristics **–** Transmission line modelling **–** Load models – Induction machine model – HVDC and FACTS controllers.

UNIT IV POWER SYSTEM STABILITY 9

Basic concepts and definitions – classification of stability – Blackouts around the world – blackout events – Stability of interconnected systems – Bad effects of Instability – Importance of stability to system operation and design.

UNIT V ENHANCING SYSTEM STABILITY 9

Method of improving stability limits – Planning measures – Power system stabilizers – Block diagram of PSS with description – operational measures – preventive control – Emergency control.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. K.R. Padiyar, "Power System Dynamics, Stability and Control", B. S. Publications, 2004.
2. P. Kundur, "Power System Stability and Control", McGraw Hill, 2006.
3. P. Sauer and M. A. Pai, "Power System Dynamics and Stability", Prentice Hall, 2007.

REFERENCES

1. L.P.Singh, "Advanced Power system Analysis and Dynamics", New Age International Publishers, 2012.
2. B.R.Gupta, "Power System Analysis and Design", S.Chand, 2008.

3. Vijay Vittal, James D. McCalley, Paul M. Anderson, A. A. Fouad, “Power System Control and Stability,IEEE Press, Wiley, 2019.

19EE19E ELECTRICAL ENERGY CONSERVATION AND AUDITING L T P C
3 0 0 3

COURSE OUTCOMES

Upon the successful completion of this course- the students will be able to

CO1: describe the elements of energy conservation and management. (K2)
CO2: Carry out energy conservation approaches in industry/Organization. (K2)
CO3: Select suitable lighting schemes for various environment (K2)
CO4: Infer the energy conservation in power generation, transmission and distribution (K2)
CO5: explain the concept of energy auditing. (K2)

UNIT I ELEMENTS OF ENERGY CONSERVATION AND MANAGEMENT 9

Energy Scenario - Role of Energy Managers in Industries – Energy monitoring, auditing & Targeting – Economics of various Energy Conservation schemes - Total Energy Systems. Scope for energy conservation and its benefits Energy conservation Principle. Energy Management concept, objectives and Energy management programmes.

UNIT II ENERGY CONSERVATION APPROACHES 9

Supply and demand side management, economic operation; reactive power, power factor correction and capacitor sizing; transformer loading and efficiency analysis; feeder loss evaluation. Energy saving opportunities in electric motors. Energy efficient control and load matching, motor selection; Industrial drives and control schemes, variable speed drives and energy conservation schemes

UNIT III ENERGY CONSERVATION IN LIGHTING 9

Energy efficient lighting schemes, Concept of lighting systems – Choice of lighting – Different Lighting technologies – Energy saving Control of lighting – Lighting standards and requirements – Energy Efficiency in Lighting – Domestic Lighting – Case studies.

UNIT IV ENERGY CONSERVATION IN POWER GENERATION, TRANSMISSION AND DISTRIBUTION 9

Types of generation - Performance improvement of existing power plant: Hybrid system, Co-generation, Demand side management, Load response programmes, conservation methods in Electrical Distribution, Transformers and lines, Technical measures to optimize T and D losses

UNIT V ENERGY AUDIT 9

Necessity of energy audit -Energy audit and its benefits, Methodology of preliminary energy audit and detailed energy audit – Phase I, Pre audit, Phase II- Audit and Phase III- Post audit, Energy audit report. Electrical Measuring Instruments - Power Analyzer, IE rules and regulations for energy audit, Electricity act.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. D. Yogi Goswami, Frank Kreith, "Energy Management and Conservation Handbook", CRC Press, 2rd edition, 2016.
2. Abbi. Y.P and Shashank Jain, "Handbook on Energy Audit and Environment Management", The Energy and Resources Institute, 2015.

REFERENCES

1. General Aspects of Energy management and Energy audit, Second Edition 2005, Bureau of Energy Efficiency, Ministry of Power, India.
2. Energy Efficiency in Electrical Utilities, Second Edition 2005, Bureau of Energy Efficiency, Ministry of Power, India.
3. Marguerite A. H Ruffner, Yacov Y. Haimes, "Energy Auditing and Conservation: Methods, Measurements, Management, and Case Studies", Taylor and Francis, 1980.
4. Energy management handbook, John Wiley and Sons – Wayne C. Turner, 2006
5. Instructions to Energy Auditors, Vol - I and Vol - II National Technical InformationServices US Dept of Commerce Springfield, VA 22161
6. LC Witte, PS Schmidt DR Brown, Industrial Energy Management and Utilization, Hemisphere Publication, Washington, 1988,

19EE22E SOLAR PHOTOVOLTAIC SYSTEMS L T P C
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: recognize the fundamentals of solar cells. (K2)
CO2: understand the various solar cell fabrication processes. (K2)
CO3: recognize the various solar PV system and their up gradations along with their benefits (K2)
CO4: design and analyze on–grid PV applications. (K3)
CO5: design off-grid PV systems and perform cost benefit analysis of PV installations. (K3)

UNIT I SOLAR CELL FUNDAMENTALS 9

Fundamentals of Semiconductors, energy band, doping, PN Junction, charge carriers, carrier motion. Photovoltaic effect, Device physics of solar cell-Principle of solar energy conversion, conversion efficiency – losses in solar cells, Solar radiation measurement: Pyranometer - Pyrheliometer.

UNIT II SOLAR CELL FABRICATION 9

Types of solar cell – Production of polycrystalline and mono crystalline silicon: Czochralski (CZ) and Float zone (FZ), wafer dicing, refining. Thin film solar cells – A-Si, CIS/CIGS, Thin film deposition techniques – Physical vapour deposition (PVD), Chemical vapour deposition (CVD) – Plasma enhanced CVD, Emerging technologies – Organic cells, Multi-junction cells, Dye sensitized cells.

UNIT III SOLAR PHOTOVOLTAIC SYSTEM 9

Introduction, Solar cell characteristics – Solar simulator: I-V measurement, solar cell classification, solar cell technologies, solar cell module and array construction, number of cells in a module and PV module specifications – maximizing the solar PV output and load matching

UNIT IV ON-GRID PV SYSTEMS 9

PV string and array – Balance of system – DC-DC converters – Inverters – Maximum power point tracking – On-Grid PV system – Design & analysis – Net Metering – Performance evaluation & monitoring – Field visit – Grid tied PV power plant

UNIT V OFF-GRID PV SYSTEMS 9

Off-Grid stand alone PV system – System sizing – Module & Battery – Charge controller – Storage Batteries for PV systems – Design & analysis - Solar photovoltaic in domestic applications and agriculture – Performance evaluation & monitoring – Economic indicators: Simple payback, Life cycle costing.

L: 45; TOTAL: 45 PERIODS

TEXT BOOK

1. Chetan Singh Solanki "Solar Photovoltaics Fundamentals, Technologies and Applications", 3rd Edition, Prentice Hall of India, 2015.

REFERENCES

1. Chetan Singh Solanki "Solar Photovoltaic Technologies and Systems – A manual for Technicians, Trainers and Engineers", Prentice Hall of India, 2014.
2. Robert Foster Majid Ghassemi, Alma Cota "Solar Energy – Renewable Energy and the Environment", CRC Press, 2010
3. James P. Dunlop "Photovoltaic Systems", 2nd Edition, American Technical Publishers, 2009
4. A. Goetzberger ,V.U. Hoffmann "Photovoltaic Solar Energy Generation", Springer-Verlag Berlin, Heidelberg, 2005.
5. Martin Green "Solar Cells: Operating principles, technology and systems application", Prentice Hall, 1997.

19EE24E SMART GRID L T P C

3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: understand the concepts of Smart Grid and its present developments. (K2)
CO2: understand about the different Smart Grid Technologies. (K2)
CO3: describe about the different smart meters and apply them in advanced metering infrastructure. (K2)
CO4: analyze power quality management in Smart Grid. (K2)
CO5: understand about the LAN- WAN and Cloud Computing for Smart Grid. (K2)

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 9

Technology Drivers - Smart energy resources- Smart substations - Substation Automation - Feeder Automation -Transmission systems: EMS - FACTS and HVDC - Wide area monitoring- Protection and control- Distribution systems: DMS- Volt/VAR control- Fault Detection- Isolation and service restoration- Outage management- High-Efficiency Distribution Transformers- Phase Shifting Transformers- Plug-in Hybrid Electric Vehicles (PHEV) - V2G and G2V.

UNIT III 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 IV POWER QUALITY MANAGEMENT IN SMART GRID 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.

UNIT V CONTROLLERS AND THEIR COORDINATION 9

Introduction and role of SCADA in smart grid - 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, CLOUD Computing - and Cyber Security Issues.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Stuart Borlase, “Smart Grid: Infrastructure, Technology and Solutions”, CRC Press, 1st Edition, 2017.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley 2015.

REFERENCES

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

19EE25E **POWER GENERATION SYSTEMS** **L T P C**
3 0 0 3

COURSE OUTCOMES

Upon the completion of this course- the students will be able to

CO1: explain the layout, construction and working of the components inside thermal power plants. (K2)

CO2: understand the layout, construction and working of the components inside nuclear power plants. (K2)

CO3: explain the layout, construction and working of the components inside hydroelectric power plants. (K2)

CO4: describe the layout, construction and working of the components inside Renewable energy power plants. (K2)

CO5: infer the applications of power plants while extend their knowledge to power plant economics and environmental estimate the costs of electrical energy production. (K2)

UNIT I COAL BASED THERMAL POWER PLANTS 9

Rankine cycle – improvisations - Layout of modern coal power plant - Subsystems of thermal power plants – Fuel and ash handling- Draught system- Feed water treatment. Binary Cycles and Cogeneration systems.

UNIT II NUCLEAR POWER PLANTS 9

Basics of Nuclear Engineering- Layout and subsystems of Nuclear Power Plants- Working of Nuclear Reactors: Boiling Water Reactor (BWR)- Pressurized Water Reactor (PWR) - CANada Deuterium- Uranium reactor (CANDU)- Breeder- Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

UNIT III HYDRO ELECTRIC POWER PLANTS 9

Selection of site- Elements of power plant- Classification- Water turbines Governor action- Hydro-electric generator- Plant layout- Pumped storage plants.

UNIT IV ALTERNATIVE SOURCES OF ENERGY 9

Solar power generation - Photo-voltaic and solar thermal generation- Wind power generation-Geo Thermal- Biomass- Fuel Cell power systems- Hydrogen Fuel Cell - Micro-hydel power plants - Tidal power generation – Onshore and Offshore Power Generation - Sustainable Development Goal (SDG) 7.

UNIT V ENERGY- ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS 9

Power tariff types- Load distribution parameters- load curve- Comparison of site selection criteria- relative merits & demerits- Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants - Sustainable Development Goal (SDG) 13.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Nag. P. K., "Power Plant Engineering", Fourth Edition, Tata McGraw Hill Publishing Company Ltd.,4th edition 2017.
2. Chakrabarti A., Soni M.L., Gupta P.V., and Bhatnagar U.S., “A Text Book on Power Systems Engineering”, Dhanpat Rai and Sons, New Delhi, 2nd Revised edition, 2016.
3. J.B.Gupta, “A Course in Power Systems”, S.K.Kataria and Sons, 2013.
4. B.R.Gupta, “Generation of Electrical Energy”, S. Chand Limited, 2017.

REFERENCES

1. M. M. El. Wakil., "Power Plant Technology", Tata McGraw Hill Publishing Company Ltd., 2010.
2. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.
3. Thomas C. Elliott Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw Hill, 1998.
4. https://www.un.org/sustainabledevelopment/energy/
5. https://www.un.org/sustainabledevelopment/climate-change/

19EE26E ELECTRICAL SAFETY L T P C
3 0 0 3

COURSE OUTCOMES

Upon the successful completion of this course- the students will be able to

CO1: explain the basic concepts of electrical equipments and statutory requirements. (K2)
CO2: understand about various electrical hazards and its causes. (K2)
CO3: describe about various protection systems. (K2)
CO4: explain the role of environment in selection- installation- operation and maintenance of equipments. (K2)
CO5: interpret about the hazardous zones of electrical industry. (K2)

UNIT I CONCEPTS AND STATUTORY REQUIREMENTS 9

Introduction – electrostatics- electro magnetism- stored energy- energy radiation and electromagnetic interference – Working principles of electrical equipment-Indian electricity act and rules-Statutory requirements from electrical inspectorate - International standards on electrical safety – First aid- Cardio Pulmonary Resuscitation (CPR).

UNIT II ELECTRICAL HAZARDS 9

Primary and secondary hazards - shocks- burns- scalds- falls - Human safety in the use of electricity - Energy leakage - clearances and insulation - Classes of insulation - Voltage classifications excess energy - Current surges - Over current and short circuit current-heating effects of current - Electromagnetic forces - Electrical causes of fire and explosion-ionization- spark and arc-ignition energy - National electrical safety code ANSI. Lightning- hazards- lightning arrestor- installation – Earthing- specifications- earth resistance- earth pit maintenance.

UNIT III PROTECTION SYSTEMS 9

Personal Protective Equipment - Fuse- circuit breakers and overload relays – Protection against over voltage and under voltage – Recent surge protection scheme for generator - Safe limits of amperage – Voltage – Safe distance from lines - Capacity and protection of conductor- joints and connections- overload and short circuit protection - No load protection - Earth fault protection.

UNIT IV SELECTION- INSTALLATION- OPERATION AND MAINTENANCE 9

Role of environment in selection - Safety aspects in application - Protection and interlock self- diagnostic features and fail safe concepts - Lock out and work permit system - Discharge rod and earthing devices - Safety in the use of portable tools - Cabling and cable joints preventive maintenance.

UNIT V HAZARDOUS ZONES 9

Classification of hazardous zones - Intrinsically safe and explosion proof electrical apparatus (IS-API and OSHA standard) - Increase safe equipment and their selection for different zones

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. John Cadick- Mary Capelli-Schellpfeffer- Dennis Neitzel- Al Winfield- “Electrical Safety Handbook”- McGraw-Hill Education- 5th edition, 2019.
2. Fordham Cooper- W.- “Electrical Safety Engineering”- Butterworth and Company- London- 3rd edition, 2013.

REFERENCES

1. Ray A. Jones- Jane G. Jones- “Electrical Safety in the Workplace”- Jones & Bartlett Learning, 2000.
2. Maxwell Adams.J- “Electrical Safety- a guide to the causes and prevention of electric hazards’- The Institution of Electric Engineers- IET, 1994.

19EE28E CAD OF ELECTRICAL APPARATUS L T P C

2 1 0 3

COURSE OUTCOMES

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

CO1: compare the conventional and field analysis based design. (K2)
CO2: interpret the basic concept of numerical approach. (K2)
CO3: explain the procedures of CAD packages. (K2)
CO4: apply the knowledge of CAD procedure to high voltage system (K3)
CO5: analyze the design electrical apparatus (K3)

UNIT I INTRODUCTION 9

Outline of Electromagnetic Fields – Electromagnetic field equations – Laplace and Poisson’s Equations – Conventional Design Procedures – Limitations – Need for field analysis based design.

UNIT II NUMERICAL COMPUTATION TECHNIQUES 9

Mathematical models – Differential / Integral equations – Finite Difference method – Finite element method – 2D field problems – Charge simulation method.

UNIT III CAD PACKAGES 9

Elements of a CAD system – Preprocessing – Modeling – Meshing – governing equations – boundary conditions and material characteristics – Setting up solution – Post processing.- Use of open source FEM software for 2D design (Electrode configurations).

UNIT IV NUMERICAL COMPUTATION OF ELECTRIC FIELD IN HIGH-VOLTAGE SYSTEM 9

Insulators and its types - Voltage Stress in Insulators – Capacitance calculation - 2D FEM software based insulator design – Electric Field Distribution around Insulator- Electric Field Distribution in a Condenser Bushing.

UNIT V DESIGN APPLICATIONS 9

Basic concepts of design in electrical machines - Single and three phase transformer – Computation of the No load Inductances – Estimation of Iron Loses and leakage inductances - Flowchart for computer-aided optimal design of Transformer –- Flowchart for computer-aided optimal design of DC machine.

L: 30; T: 15; TOTAL: 45 PERIODS

TEXT BOOKS

1. S.J. Salon, “Finite Element Analysis of Electrical Machines”, Springer, Yes DEE publishers, Indian reprint, 2007.
2. K.J.Binns, P.J.Lawrenson and C.W.Trowbridge, “The Analytical and Numerical Solution of Electric and Magnetic Fields”, John Wiley and sons, 1993.

REFERENCES

1. Joao Pedro, A.Bastos and Nelson Sadowski, “Electromagnetic Modeling by Methods”, Marcell Dekker Inc., 2003.
2. S.R.H.Hoole, “Computer Aided Analysis and Design of Electromagnetic Devices”, Elsevier, NewYork, 1989.
3. Matthew N. O. Sadiku, “Principles of Electromagnetics”, Oxford University Press, New Delhi, 2015.
4. Nathan Ida, Joao P A Bastos, “Electromagnetics and calculation of fields”, Springer Verlag, 2012.
5. S.S.Rao, “The Finite Element Method in Engineering”, Elsevier, 2011.
6. Matthew. N.O. Sadiku, S.V. Kulkarni, “Elements of Electromagnetics”, Sixth Edition, Oxford University Press, Asian Edition 2015.
7. Nicola Biyanchi, “Electrical Machine analysis using Finite Elements”, Taylor and Francis Group, CRC Publishers, 2005.

19EE30E **INSULATION TECHNOLOGY** **L T P C**
3 0 0 3

COURSE OUTCOMES

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

CO 1: summarize the general properties of dielectric materials (K2)
CO 2: dissect the different breakdown mechanism in gaseous dielectrics (K2)
CO 3: perceive the various breakdown mechanisms in solid dielectrics (K2)
CO 4: appraise the conduction and breakdown mechanism in liquid dielectrics (K2)
CO 5: select the different dielectric materials in electrical equipments applications (K2)

UNIT I INTRODUCTION 9

Classification of insulating materials - classification based on temperature – Insulation resistance - Factor affecting insulation resistance -- Polarisation – Polarisation Materials – Polarisability of dielectric material - Dipole-Electric Dipole moment – Permeability - Dependence of permittivity on temperature, pressure, humidity and voltage – Permittivity of mixtures – Bipolar-electric field in mixed dielectrics.

UNIT II BREAKDOWN IN GASES AND VACCUM 9

Basic ionization process – Townsend current growth equations – Townsend criterion for spark breakdown – Streamer mechanisms –– Paschen's law – Breakdown in non-uniform fields – Vacuum: Pre-breakdown conduction – Factors affecting the breakdown voltage-moisture interaction with insulation

UNIT III BREAKDOWN IN SOLIDS 9

Intrinsic breakdown – Electromechanical breakdown – Thermal breakdown – Chemical and electrochemical deterioration – Breakdown due to tracking and treeing – Partial discharges - degradable and non degradable insulation.

UNIT IV ELECTRICAL CONDUCTION AND BREAKDOWN IN LIQUIDS 9

Pure liquids and commercial liquids – Purification – Natural conduction – Induced conduction – Process of conduction – Breakdown phenomena and electric strength of pure liquids – Breakdown of commercial liquids - Alternating liquid dielectric – latest development-cryogenic insulation - effect of moisture and importance of purity - alternate insulation

UNIT V APPLICATION OF DIELECTRIC MATERIALS 9

Classification based on insulating materials and application – Application of insulating materials in transformers, rotating machines, circuit breakers, cables, power capacitors and bushings.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Adrinaus, Dekker J., "Electrical Engineering Materials", Prentice Hall of India Pvt. Ltd., New Delhi, 2015.
2. Alston L.L, "High Voltage Technology", Oxford University Press, London, 1968 (B.S. Publications, First Indian Edition, 2008).

REFERENCES

1. Kuffel E., Zaengl W.S. and Kuffel J., "High Voltage Engineering Fundamentals", Elsevier India Pvt. Ltd, 2008.
2. Dieter Kind and Hermann Karner, "High Voltage Insulation Technology", (Translated from German by Narayana Rao Y., Friedr. Vieweg & Sohn, Braunschweig), 1985.
3. Naidu M.S. and Kamaraju V., "High Voltage Engineering", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2020.
4. Ushakov V.Y., "Insulation of High Voltage Equipment", Springer, 2004.

19EE31E EHV POWER TRANSMISSION L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: identify transmission (HVAC and HVDC) and distribution voltage levels. (K2)
CO2: extract transmission line parameters. (K2)
CO3: locate required HVDC transmission in power system. (K2)
CO4: know the uses of placing FACTS devices. (K2)
CO5: compute electrostatic and magnetic fields of EHV lines. (K2)

UNIT I TRANSMISSION LINE TRENDS 9

Standard transmission voltages, average values of line parameters – Power handling capacity and line losses - number of lines, Advantages and disadvantages of HVAC and HVDC system.

UNIT II LINE AND GROUND PARAMETERS 9

Resistance, Temperature rise and current carrying capacity of conductors. Properties of Bundle conductors – Calculation of L and C parameters – Modes of propagation – Effect of Earth.

UNIT III HVDC SYSTEM 9

HVDC Power transmission–Description, principles of operation and Planning for HVDC transmission–Operating problems– HVDC transmission based on VSC –Types and applications of MTDC systems.

UNIT IV FACTS 9

Basic concepts – Reactive power control, uncompensated transmission line, series compensation, SVC, thyristor control, series capacitor, static synchronous compensator, unified power flow controller and applications.

UNIT V ELECTROSTATIC AND MAGNETIC FIELDS OF EHV LINES 9

Electric shock – threshold currents – Calculation of electrostatic fields and magnetic fields of AC and DC lines – Effect of fields on living organism – Electrical field measurement – Drone based thermal imaging for electrical stress analysis.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. S Kamakshaiah & V Kamaraju, "HVDC Transmission", Tata Mcgraw Hilll Publishers, 2011.

2. Rakosh Das Begamudre, “Extra high voltage AC transmission Engineering”, New Age International Publishers, Third Edition, 2013.
3. Narain G Hingorani, “Understanding FACTS” Standard Publishers, 1994.

REFERENCES

1. C.L. Wadhwa “Electrical Power Systems”, New Age International Publishers, Fourth Edition, 2005.
2. K.R. Padiyar, “HVDC Power Transmission System”. New Age International Publishers, First Edition, Reprint 2005.
3. M.L. Soni, P.V. Gupta, U.S. Bhatnagar, A.Chakrabarti, “A Text Book on Power System Engineering”, Dhanpat Rai & Co., 1998.
4. Mafen Abdel – Salam, Hussein Anis, Ahdab E-Moshedy, Roshdy Padwan “ High Voltage Engineering – Theory & Practice”, Marcel Dekker Inc., 2000
5. Microtran Power System Analysis Corporation, “Microtran Reference Manual”, Vancouver Canada. (Website: www.microtran.com)
6. R.K. Rajput, “A Text Book of Power System Engineering”, Laxmi Publications, 2015.
7. Xiao–Ping Zhang, “Restructured Electric Power Systems”, Wiley Publications, 2010.
8. Shobhit Gupta, and Deepak Gupta, “EHV AC/DC Transmission”, genius publications, 2014.
9. A. Chakrabarti , D. P. Kothari and A. K. Mukhopadhyay, “Performance, Operation and Control of EHV Power Transmission System”, A H Wheeler Publishing Co Ltd, 1999.
10. https://www.drone-thermal-camera.com/thermodiagnostics-in-the-power-engineering-sector/

19EE32E HVDC TRANSMISSION SYSTEMS L T P C
3 0 0 3

COURSE OUTCOMES

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

CO 1: describe the advantages of DC transmission over AC transmission (K2)
CO 2: analyze HVDC converters (K2)
CO 3: describe the various types, control and protection of MTDC systems (K2)
CO 4: analyze the power flow in AC and DC system (K2)
CO 5: describe the new concepts in HVDC converters (K2)

UNIT I DC POWER TRASNSMISSION TECHNOLOGY 9

Introduction- comparison of HVAC and HVDC transmission – Application of HVDC transmission – Components of HVDC transmission Systems – Planning for HVDC transmission Systems- Modern trends in HVDC transmission systems – Schematic diagram of typical HVDC transmission system

UNIT II ANALYSIS OF HVDC CONVERTERS 9

Pulse Number – choice of converter configurations - simplified analysis of Graetz circuits – converter bridge characteristics – characteristic of twelve pulse converter – detailed analysis of converters

UNIT III MULTI-TERMINAL DC SYSTEMS 9

Introduction **–** Potential applications of MTDC systems **–** Types of MTDC systems **–** Control and protection of MTDC systems **–** Study of MTDC systems.

UNIT IV POWER FLOW ANALYSIS AND STABILITY ANALYSIS IN AC/DC SYSTEMS 9

Per unit system for DC Quantities **–** Modeling of DC links **–** Solution of DC load flow **–** Solution of AC-DC power flow **–** Case studies - Basic Concepts: Power System Angular, Voltage and Frequency Stability.

UNIT V NEW CONCEPTS IN HVDC CONVERTERS AND SYSYEMS 9

Introduction **–** Advanced devices – new concepts for thyristors devices – compact converter stations – GTO based voltage source converters – DC cable developments- Direct connections of generators to HVDC converters – small HVDC tappers.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Padiyar K.R., "HVDC Power Transmission Systems", New Age International (P) Ltd., New Delhi, Reprinted 2017.
2. Arrillaga J., "High Voltage Direct Current Transmission", Peter Pregrinus, London, 2007.

REFERENCES

1. Kundur P., "Power System Stability and Control", Tata McGraw-Hill, Reprinted 2009.
2. Erich Uhlmann, "Power Transmission by Direct Current", BS Publications, 2004.
3. Sood V.K., "HVDC and FACTS controllers – Applications of Static Converters in Power System", Kluwer Academic Publishers, April 2004.

19EE34E DIGITAL CONTROL SYSTEMS L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: explain the components of digital control system. (K2)
CO2: Illustrate the significance of pulse transfer functions and their analysis. (K2)
CO3: discuss the state variable analysis in discrete domain. (K2)
CO4: analyze the stability of the system in discrete domain. (K2)
CO5: design discrete controller using various techniques. (K2)

UNIT I INTRODUCTION TO DIGITAL CONTROL SYSTEM 9

Introduction to digital control – Sampling Process – Effect of quantization - Sample and Hold Circuit – Zero and First Order hold – Z-Transform – Inverse Z- Transform – Region of convergence – Initial and Final Value Theorem

UNIT II PULSE TRANSFER FUNCTION AND TIME RESPONSE 9

Block diagram reduction methods – Reduction Rules- Multi-loop – MIMO Systems – Signal Flow Graph- steady state error – error transfer functions- Error Constants-Time-Domain Analysis of Second Order Systems-Time Response

UNIT III STATE SPACE APPROACH FOR DISCRETE TIME SYSTEMS 9

State space models of discrete systems - State space analysis: Controllability, reachability, Reconstructibility and observability analysis. Effect of pole zero cancellation on the controllability and observability.

UNIT IV FREQUENCY RESPONSE AND STABILITY ANALYSIS 9

Introduction-Jury Stability Test- Schur-Cohn stability Test- Bilinear transformation- Stability by Pole Location –Bode Plot- Nyquist Plot - Lyapunov Stability Theorem – analysis

UNIT V DESIGN OF DISCRETE CONTROLLER 9

Design of Digital Control System - Design of Discrete PID Controller - Design of discrete state feedback controller - Design of set point tracker - Design of Discrete Observer for LTI System.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS:

1. B.C.Kuo, “Digital Control System”, 2nd Edition, Oxford University Press, 2012.
2. M.Sami Fadali, Antonio Visioli, “Digital Control Engineering Analysis and Design”, Academic Press, 2013.

REFERENCES:

1. M.Gopal, “Digital Control and State Variable Methods”, Tata McGraw Hill, 3rd Edition, 2009.
2. V.I.George and C.P.Kurien, “Digital Control System”, Cengage Learning, 2012.
3. Kannan M.Moddgalya, “Digital Control”, Wiley India, 2007.
4. C.L.Philips and J.M.Pan, “Feedback Control System”, Pearson, 2013.

19EE35E CONTROL SYSTEMS DESIGN L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: Distinguish the effect of continuous system and discrete system. (K2)
CO2: Design controller for continuous and discrete system by root-locus. (K3)
CO3: Design compensator using frequency response analysis. K3)
CO4: Illustrate state variable and its use in controller design (K2)
CO5: Demonstrate the LQR problem and formulate for various application. (K2)

UNIT I CONTINUOUS AND DISCRETE SYSTEMS 9

Introduction - types of system - Need for discretization – comparison between discrete and analog system. Sample and Hold devices – sampling effect: transfer function and state models– Analysis of discrete model.

UNIT II TIME RESPONSE DESIGN 9

Design specifications- Continuous domain - Limitations- Controller structure- Multiple degrees of freedom- PID controllers - Root locus design-Discretization & Direct discrete design.

UNIT III FREQUENCY RESPONSE DESIGN 9

Digital controller design - Lag-lead compensators – Design using Bode plots- use of Nichol’s chart -Jury’s stability test.

UNIT IV STATE VARIABLE DESIGN 9

Pole Assignment Design- state and output feedback-observers - Estimated state feedback-Design examples (continuous & Discrete) - Full state observer – Reduced order state observer.

UNIT V LQR AND LQG DESIGN 9

Formulation of LQR problem- Pontryagin's minimum principle and Hamiltonian solutions- Ricatti's equation – Optimal estimation- Kalman filter–solution to continuous and discrete systems –QNET Rotary inverted pendulum controller - case study.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. M.Gopal, "Digital Control and State variable methods" Mcgraw hill 4th edition, 2017.
2. Graham C. Goodwin, Stefan F. Graebe and Mario E. Salgado "Control system Design",PHI, 2009.

REFERENCES

1. G. F. Franklin, J. D. Powell and M Workman, "Digital Control of Dynamic Systems", PHI, 2002.
2. Richard C. Dorf and Robert H Bishop, "Modern control systems", 12th Edition, Addison Wesley, 2014.
3. Benjamin C. Kuo "Digital control systems", Oxford University Press, 2004
4. M. Gopal, "Modern control system Theory" New Age International, 2005.
5. J.J. D'Azzo, C.H. Houpis and S.N Sheldon, "Linear Control system analysis and design", 5th Edition, CRC Press, 2003

19EE37E LOGIC AND DISTRIBUTED CONTROL SYSTEM L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: describe the hardware components and Programming with PLC. (K2)
CO2: develop the PLC programming routines with the instructions in PLC. (K2)
CO3: recognize the standards and safety precautions in PLC installation. (K2)
CO4: demonstrate the functionality of SCADA for real applications (K2)
CO5: explain the basic concepts of DCS and its Interfacings. (K2)

UNIT I PROGRAMMABLE LOGIC CONTROLLER 9

Advantages of PLC over relay logic – Parts of PLC –Architecture –Principles of operation – scan time and scan cycle –PLC versus Computer –PLC Size and Application – PLC Hardware components –Programming timers and counters - Case study with multiple I/O parameters and logics.

UNIT II INSTRUCTION IN PLC 9

Ladder programming Instructions in PLC – Program control instructions – Data manipulation instructions – math instructions – sequencer and shift register instructions – Programming concept using Instructions. Process of automated drill control - traffic light control system.

UNIT III PRACTICE IN PLC INSTALLATION 9

PLC Installation Practices – Editing and Troubleshooting –Data acquisitions system – System integrity and safety – fail safe wiring and programming – system interlocks – time synchronization – time stamping events - Application of PLC in industry.

UNIT IV SUPERVISORY CONTROL AND DATA ACQUISITION 9

SCADA Functional requirements and Components – General features – Configurations - RTU (Remote Terminal Units) as PLC – Master-slave concept - watchdog controller for error detection – H/W and S/W fault detection–SCADA Communication: Field bus – Profibus – Application in power sector, oil & gas industry.

UNIT V DISTRIBUTED CONTROL SYSTEM AND ITS INTERFACING 9

DCS –Evolution of Architectures –Comparison – selecting DCS - Local control unit – Process interfacing issues –Communication facilities –Low level and high level Operator interfaces – Low level and high level Engineering interfaces - Low and high level control topology - GPS clock synchronizer in DCS

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Petruzella, “Programmable Logic Controller”, Tata McGraw Hill Private Limited, 5th Edition, 2017.
2. David Bailey, Edwin Wright “Practical SCADA for Industry”, Elsevier 2003.
3. Michael P. Lukas, “Distributed Control System”, Van Nostrand Reinhold Co., Canada, 1986.

REFERENCES

1. Lawal.A.B. “PLC programming using RSlogix 500 & real world applications” AB prominents, 2020
2. Krishna Kant, “Computer based Industrial Control”, Prentice Hall Private Limited, New Delhi, 2014.
3. M. Chidambaram, “Computer Control of Processes”, Narosa Book Distributors Private Limited, 2002.
4. John R. Hackworth, Frederick D. Hackworth “Programmable logic controllers: Programming methods and applications”
5. Gordon Clarke, Deon Reynders, Edwin Wright, “Practical Modern SCADA Protocols” Elsevier 2004.
6. Manoj K S, “Industrial automation with SCADA concepts, communications and security”, notion press 2019.
7. https://developpaper.com/application-of-gps-clock-synchronizer-in-dcs-control-system/
8. http://nptel.ac.in/courses/108106022

19EE38E BIOMEDICAL INSTRUMENTATION L T P C

3 0 0 3

COURSE OUTCOMES

Upon completion of this course, students will have the ability to

CO1: Outline the relation of biological system with electrical behavior and sensing. (K2)

CO2: Explain the ways of probing signals from biological system within safety measures. (K2)

CO3: Describe the non-electrical parameter measurements and diagnosis equipment. (K2)

CO4: Recognize the modern biomedical methods of imaging techniques and their analysis. (K2)

CO5: Understand the life assisting techniques, medical robotics, and prosthetics. (K2)

UNIT I FUNDAMENTALS OF BIOMEDICAL ENGINEERING 9

Cell and its structure – Resting potential - Action Potential and its propagation – Nervous system - cardiovascular systems- Respiratory systems -Kidney – Biomechanics of bone – Biomechanics of soft tissues -Physiological signals and transducers– selection criteria – Piezo electric, ultrasonic transducers –Fiber optic temperature sensors - Basic components of biomedical system.

UNIT II ELECTRICAL PARAMETERS ACQUISITION AND ANALYSIS 9

Electrodes–floating electrodes – pre gelled disposable electrodes – Micro, needle and surface electrodes – Amplifiers: Preamplifiers, differential amplifiers, chopper amplifiers – Isolation amplifier – ECG – EEG – EMG – ERG – Lead systems and recording methods – Typical waveforms – Electrical safety instruments in medical environment, shock hazards – leakage current.

UNIT III NON ELECTRICAL PARAMETERS MEASUREMENT AND DIAGNOSIS 9

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

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 – Dialyzers – Lithotripsy – ICCU patient monitoring system – Nano Robots – Robotic surgery –Orthopedic prostheses fixation.

L: 45; TOTAL: 45PERIODS

TEXT BOOKS

1. Leslie Cromwell, “Biomedical Instrumentation and Measurement”, Prentice Hall of India, New Delhi, 2nd Edition, 2012.
2. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw-Hill, New Delhi, 3rd Edition, 2014.
3. Joseph J Carr and John M.Brown, “Introduction to Biomedical Equipment Technology”, John Wiley and sons, New York, 4th Edition, 2012

REFERENCES

1. John G. Webster, “Medical Instrumentation Application and Design”, Wiley, New York, 4th Edition, 2015.
2. Duane Knudson, “Fundamentals of Biomechanics”, Springer, 2nd Edition, 2012.

3. Valérie Bélanger, Nadia Lahrichi , Ettore Lanzarone, Semih Yalçındağ ., "Health Care Systems Engineering ", Springer, 2020.
4. Ed. Joseph D. Bronzino, "The Biomedical Engineering Hand Book", CRC Press Taylor & Francis Group, 4th Edition, 2015.
5. M. Arumugam, 'Bio-Medical Instrumentation', Anuradha Agencies, 2003.

19EE39E ADVANCED CONTROL THEORY L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: explain the characteristics of nonlinear systems. (K2)
CO2: Describe the stability of the system using Lyapunov theorem. (K2)
CO3: illustrate the parameters to design optimal control problems. K2)
CO4: Demonstrate the significance of robustness of controller design. (K2)
CO5: Develop adaptive control scheme with model reference. (K3)

UNIT I NON-LINEAR SYSTEM 9

Methods of linearization– Phase plane analysis of non-linear system– Derivation of describing functions for common nonlinearities – Describing function analysis of non-linear systems – limit cycles - Singular points – Stability of oscillations.

UNIT II LYAPUNOV STABILITY ANALYSIS 9

Lyapunov stability definition – Lyapunov stability theorem – Lyapunov functions for non-linear system – Krasovskii method – Variable gradient method – Direct method of Lyapunov and linear systems.

UNIT III OPTIMAL CONTROL 9

Parameter optimization: Servo mechanism – Optimal control problems: Transfer function and State variable approaches – State regulator problem – Infinite time regulator problem– Output regulator and Tracking problem – Parameter optimization: regulators.

UNIT IV ROBUST CONTROL 9

Sensitive parameters of system – Analysis of robustness – Systems with uncertain parameters – Design of robust control systems – PID controller – H ∞ Control - Design of robust PID controller – Design of robust internal model control system – Pseudo quantitative feedback system.

UNIT V ADAPTIVE CONTROL 9

Model reference adaptive control – MIT rule – MRAC using Lyapunov theory – First order systems –higher order systems – MRAC for a single link manipulator – Self tuning control.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Gopal M, "Modern Control System Theory", New Age International, 2021.
2. Richard C. Dorf and Robert H Bishop, "Modern control systems", 12th Edition, Addison Wesley, 2014

REFERENCES

1. Cheng D, Sun Y, Shen T and Ohmori H, "Advanced Robust and Adaptive Control Theory and Applications", New Age International, 2010.

2. Astrom KJ & Wittenmark B, “Adaptive Control”, Dover Publications, 2013.
3. Kirk D.E, “Optimal Control Theory: An Introduction”, Dover Publications, 2012.
4. K.Ogatta, “Discrete time control system”, PHI, 2010.
5. B.C.Kuo,” Digital Control Systems”, SRL Publication, 2003.

19EE40E SOFT COMPUTING FOR ELECTRICAL ENGINEERING L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: Interpret the components of fuzzy logic system. (K2)
CO2: Distinguish various structures of ANN. (K2)
CO3: Describe the basic concepts of genetic algorithms. (K2)
CO4: Apply ANN and FLC to various electrical applications. (K3)
CO5: Employ GA to power system optimization and control applications. (K3)

UNIT I FUZZY LOGIC SYSTEM 9

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning – Fuzzification, inferencing and defuzzification methods – Fuzzy knowledge and rule bases – Fuzzy logic modelling

UNIT II ARTIFICIAL NEURAL NETWORKS 9

Basic concepts – Types of activation functions – McCulloch–Pitts neuron model – Adaline and Madaline– Back Propagation Neural Networks – Kohenen Neural Network-Architecture – Feed forward and Feedback – Multilayer Perceptron– Hopfield network – Self organizing network.

UNIT III GENETIC ALGORITHM 9

Basic concepts – Functional evaluation and constraint handling – Representation – Crossover – Mutation – Selection schemes – Stopping criteria.

UNIT IV APPLICATIONS OF FLC AND ANN 9

Implementation of fuzzy logic controller for motor drives – Identification and control of linear and nonlinear dynamic systems using Neural Network – ANN application to short term load forecasting .

UNIT V APPLICATIONS OF GA 9

GA application to power system optimization problem – Economic dispatch, load scheduling and unit commitment problems – System Identification and PID controller tuning.- Multilevel inverter..

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Jacek.M.Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House, 2006.
2. Kosko, B. "Neural Networks And Fuzzy Systems", Prentice Hall Private Limited, 2004.

REFERENCES

1. S.N. Sivanandam & S.N.Deepa, “Principles of Soft Computing”, Wiley India Private Limited, 2013.
2. S. N. Sivanandam,S. Sumati&S. N. Deepa, “Introduction to Fuzzy Logic using MATLAB”, Springer, 2007.
3. Klir G.J. and Folger T.A. "Fuzzy sets, uncertainty and Information", Prentice Hall Private Limited, 2010.
4. Zimmerman H.J. "Fuzzy set theory–and its Applications" Kluwer Academic Publishers, 2014.
5. Driankov, and Hellendroon, "Introduction to Fuzzy Control", Narosa Publishers, 2nd Edition, 2011.
6. Samir Roy, “Introduction to Soft Computing: Neuro – Fuzzy and Genetic Algorithms” Pearson Education, 1st Edition, 2013.
7. Fakhreddine O. Karray, “Introduction to Soft Computing: Neuro – Fuzzy and Genetic Algorithms”, Pearson Education, 1st Edition, 2009.
8. Devendra K. Chaturvedi, “Soft Computing: Techniques and its Applications in Electrical Engineering”, Springer, 2008.

19EE41E DIGITAL SIGNAL PROCESSING L T P C

3 0 0 3

COURSE OUTCOMES

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

CO1: compute the frequency response using DFT and the FFT algorithms. (K2)
CO2: design and realize IIR digital filters. (K3)
CO3: design and realize FIR digital filters. (K3)
CO4: recognize the effects of finite word length in DSP. (K2)
CO5: explain the architecture and applications of digital signal processors. (K2)

UNIT I DISCRETE FOURIER TRANSFORM 9

Need and benefits of Digital Signal Processing – Signal classification - Fourier Series and Fourier Transform -Discrete Fourier Transform (DFT) - Properties – DIT-FFT and DIF-FFT radix2 algorithms - linear filtering via circular convolution - Inverse FFT

UNIT II INFINITE IMPULSE RESPONSE DIGITAL FILTERS 9

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

UNIT III FINITE IMPULSE RESPONSE DIGITAL FILTERS 9

Symmetric and Antisymmetric FIR filters - Linear phase FIR filters – Characteristics and applications of FIR filters - Windowing Techniques - Design using Rectangular, Hamming, Hanning, Blackmann and Kaiser Windows - Realization of FIR filters

UNIT IV FINITE WORD LENGTH EFFECTS 9

Fixed point and floating point number representations - Comparison - Truncation and Rounding errors A/D quantization noise – Product round off errors - Overflow error – Round off noise power - limit cycle oscillations due to product round off and overflow errors - Finite word length effects in IIR filters and FFT algorithms.

UNIT V APPLICATIONS OF DIGITAL SIGNAL PROCESSING 9

Architecture of TMS320LF2407 – On-chip peripherals – Addressing modes – Instruction set of TMS320LF2407 - PWM generation – DSP based stepper motor control(Qualitative treatment only) - optimal filter- ARMA – LMS -Forward and Backward Linear prediction and FIR Wiener Filter.

L: 45; TOTAL: 45 PERIODS

TEXT BOOK

1. John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing: Principles, algorithms and applications”, Pearson Prentice Hall, 2014.

REFERENCES

1. Li Tan, Jean Jiang, “Digital Signal Processing: Fundamentals and applications” Academic press, 2013.
2. Salivahanan.S, Gnanpriya.C., “Digital Signal processing”, McGraw Hill, 2011.
3. Ifaeachor E.C, Jervis B. W., “Digital Signal processing: Practical approach”, Pearson publication, 2002.
4. Shaila Apte, “Digital Signal Processing”, Wiley India Publication, 2013.
5. Navas.K.A., Jayadevan.R., “Lab Primer through MATLAB”, PHI, 2014.

19EE42E ROBOTICS AND AUTOMATION L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: explain the individual components of Robotics. (K2)
CO2: summarize the kinematics transformation techniques used in Robotics. (K2)
CO3: illuminate the Jacobian matrix used for robotic differential motion and velocities. (K2)
CO4: describe the role of image processing and vision system for an automation of robot. (K2)
CO5: demonstrate the real time robotic system for an application (K2)

UNIT I INTRODUCTION TO ROBOTICS 9

Robot: components – Classification- DOF-Robot joints coordinates- Reference frames-workspace– Actuators: Electric, Hydraulic, Pneumatic - Sensors: Position - velocity - acceleration - Torque sensors-tactile and touch sensors.

UNIT II KINEMATICS 9

manipulator kinematics - link description, link connection, affixing frames to links, Forward kinematics - Matrix representation-homogenous transformation - DH representation – Inverse Kinematics - solution and programming

UNIT III DIFFERENTIAL MOTION AND VELOCITIES 9

Jacobian-differential motion of frames-Interpretation-calculation of Jacobian- Inverse Jacobian- Design-Lagrangian mechanics-dynamic equations-static force analysis– degeneracy and dexterity.

UNIT IV IMAGE PROCESSING AND VISION SYSTEMS 9

2D and 3D images – representation-noise and edges convolution masks-Processing techniques-noise reduction - edge detection - segmentation- Image analysis and object recognition.

UNIT V CASE STUDIES 9

Robots in industry: Robotic Arm – material handling - pick and place - spot welding – spray coating – automation in assembly line and inspection. Robots in medicine: Prosthetics – service robots – clinical robots - Electronic travel aids (ETA) - Navigational Assistance to Visually Impaired (NAVI).

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Saeed B. Niku, “Introduction to Robotics: analysis, Control, applications”, 3rd Edition, Pearson Education, 2020
2. Mikell P.Groover, “Industrial Robotics: Technology Programming and Applications” 2nd Edition, Tata Mcgraw Hill, 2012.

REFERENCES

1. R.K. Mittal and I J Nagrath, “Robotics and Control”, Tata McGraw Hill, 4th Reprint, 2005.
2. Fu, Gonzalez and Lee McGraw hill, “Robotics”, International TATA McGraw Hill, 2008.
3. R.D. Klafter, TA Chmielewski and Michael Negin, “Robotic Engineering, an Integrated Approach”, Prentice Hall of India, 2003.
4. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1999.
5. Ramachandran Nagarajan, “Introduction to industrial robotics” Pearson publication 2016.
6. Mark W. Spong, Seth Hutchinson, M.Vidyasagar “Robot Dynamics and Control “, Wiley publication 2004.

19EE44E EMBEDDED SYSTEMS L T P C

3 0 0 3

COURSE OUTCOMES

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

CO 1: expose the fundamentals of Embedded Systems. (K2)

CO 2: describe about Hardware / Software in a embedded system design. (K2)

CO 3: understand the memory interfacing with microprocessor/ controllers. (K2)

CO 4: discuss the programming concepts of embedded systems. (K2)

CO 5: explain the design aspects in interfacing hardware with system. (K2)

UNIT I INTRODUCTION TO EMBEDDED HARDWARE AND SOFTWARE 9

Terminology – Gates – Timing diagram – Memory – Microprocessor buses – Direct memory access – Interrupts – Built interrupts – Interrupts basis – Shared data problems – Interrupt latency - Embedded system evolution trends – Interrupt routines in an RTOS environment .

UNIT II SYSTEM MODELLING WITH HARDWARE/SOFTWARE PARTITIONING 9

Embedded systems, Hardware/Software Co-Design, Co-Design for System Specification and modeling - Single-processor Architectures & Multi-Processor Architectures, comparison of Co-Design Approaches, Models of Computation, Requirements for Embedded System Specification, Hardware/Software Partitioning Problem, Hardware/Software Cost Estimation, Generation of Partitioning by Graphical modelling, Formulation of the HW/SW scheduling, Optimization.

UNIT III MEMORY AND INTERFACING 9

Memory: Memory write ability and storage performance – Memory types – composing memory – Advance RAM interfacing communication basic – Microprocessor interfacing I/O addressing – Interrupts – Direct memory access – Smart Storage Memory - Arbitration multilevel bus architecture – Serial protocol – Parallel protocols – Wireless protocols – Digital camera example.

UNIT IV PROGRAMMING LANGUAGES AND TOOLS 9

Programming Languages and Tools – Desired language characteristics – Data typing – Control structures – Facilitating Hierarchical Decomposition, Packages, Run time (Exception) Error handling – Overloading and Generics – Multitasking – Low level programming – Task Scheduling – Timing Specifications – Programming Environments – Run – time support.

UNIT V SYSTEM DESIGN – CASE STUDY 9

Interfacing LCD Display – Keypad Interfacing - Generation of Gate signals for converters and Inverters - Motor Control – Controlling DC/ AC appliances – Measurement of frequency - Stand alone Data Acquisition System – Applications in Automobile Industries.

L: 45; TOTAL: 45 PERIODS

TEXT BOOK

1. C.M. Krishna, Kang G. Shin, “Real – Time Systems”, McGraw – Hill International Editions, Reprinted 2013.
2. Rajib Mall, ”Real-time systems: theory and practice”, Pearson Education, 2007
3. Philip.A.Laplante, “Real Time System Design and Analysis”, Prentice Hall of India, 3rd Edition, April 2004
4. Raj Kamal, “Embedded Systems- Architecture, Programming and Design” Tata McGraw Hill, Reprinted 2018.

REFERENCES

1. Steve Heath, “Embedded System Design”, Elsevier, Second Edition, Reprinted 2017.

2. Ralf Niemann, “Hardware/Software Co-Design for Data Flow Dominated Embedded Systems”, Kluwer Academic Pub, 1998.
3. Stuart Bennett, “Real Time Computer Control – An Introduction”, Prentice Hall of India, 1998.
4. S.T. Allworth and R.N.Zobel, “Introduction to real time software design”, Macmillan, 1987.
5. R.J.A Buhur, D.L Bailey, “An Introduction to Real – Time Systems”, Prentice – Hall International, 1999.

19EE45E MEMS AND NEMS L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: outline the importance of scaling in MEMS. (K2)
CO2: identify the properties of MEMS fabrication materials (K2)
CO3: describe the fabrication process of MEMS (K2)
CO4: utilize MEMS technology for various applications. (K2)
CO5: investigate the properties and applications of nano systems. (K2)

UNIT I INTRODUCTION TO MEMS AND SCALING 9

MEMS and Microsystems -development of MEMS technology - MEMS future and applications - scaling in geometry, rigid body dynamics, electrostatic, electromagnetic forces, electricity, heat transfer.

UNIT II MATERIAL PROPERTIES OF MEMS 9

Substrates - crystal structure- miller indices- properties silicon compounds -silicon dioxide, silicon carbide, silicon nitride, polycrystalline silicon-gallium arsenide-quartz-piezoelectric crystals –polymers.

UNIT III MICROMACHINING PROCESS 9

Bulk micromachining -Isotropic and anisotropic etching, wet etchants, etch stop, dry etching, surface micromachining -Introduction, process, associated problems-LIGA Process and electroplating -Integration of electronics and MEMS technology-packaging - die attach, Wire bond and Sealing

UNIT IV MEMS SENSORS AND ACTUATORS 9

Micro sensors – Micro actuators - Mechanical: Beam and Cantilever – Capacitive effect – MEMS Gyroscopes – Micromachined thermocouple probe – Heat pumps – MEMS relay – Shape Memory Alloys. RF based communication system – MEMS inductors – Filter – Resonator – Switches – Phase shifter.

UNIT V NEMS 9

Properties of nano materials: structural, thermal, mechanical, magnetic, optical properties– fabrication and process techniques – integration of nano systems and devices – applications – Single Electron Transistor – Carbon Nano tube Devices: Modeling, analysis and simulation-simulation of Actuators - Pressure transducer.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata Mc-Graw Hill Private Limited, 2007.
2. Nitaigour Premchand Mahalik, "MEMS", Tata McGraw Hill Private Limited, 2012.
3. James JAllen, —Micro Electro Mechanical System Design CRC Press-Taylor & Francis‖, New York, 2005.

REFERENCES

1. Nadim Maluf," An introduction to Micro electro mechanical system design", Artech House, 2000.
2. Mohamed Gad–el–Hak," The MEMS Handbook", CRC press Baco Raton, 2006.
3. Chang Liu, "Foundations of MEMS", Pearson Education India Limited, 2012,
4. Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures" CRC Press, 2007
5. W.R.Fahrner, "Nanotechnology and Nanoelectronics: Materials, Devices, Measurement Techniques", Springer, 2007.

19EE46E VLSI DESIGN L T P C
3 0 0 3

COURSE OUTCOMES

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

CO 1: Describe the concepts of digital building blocks using MOS transistor. (K2)
CO2: Design combinational MOS circuits and power strategies. (K2)
CO3: Design and construct Sequential Circuits and Timing systems. (K2)
CO 4: Explain the performance of various arithmetic building blocks.(K2)
CO 5: Write verilog HDL code for the digital system components. (K2)

UNIT I INTRODUCTION TO MOS TRANSISTOR 9

MOS Transistor, CMOS logic, Inverter, Pass Transistor, Transmission gate, Layout Design Rules, Gate Layouts, Stick Diagrams, Long-Channel I-V characteristics, C-V characteristics, Non ideal I-V Effects, DC Transfer characteristics, RC Delay Model, Elmore Delay, Linear Delay Model, Logical effort, Parasitic Delay, Delay in Logic Gate, Scaling.

UNIT II COMBINATIONAL MOS LOGIC CIRCUITS 9

Circuit Families: Static CMOS, Ratioed Circuits, Cascade Voltage Switch Logic, Dynamic Circuits, Pass Transistor Logic, Transmission Gates, Domino, Dual Rail Domino, CPL, DCVSPG, DPL, Circuit Pitfalls. Power: Dynamic Power, Static Power, Low Power Architecture.

UNIT III SEQUENTIAL CIRCUIT DESIGN 9

Static latches and Registers, Dynamic latches and Registers, Pulse Registers, Sense Amplifier Based Register, Pipelining, Schmitt Trigger, Monostable Sequential Circuits, Astable Sequential Circuits. Timing Issues: Timing Classification of Digital System - Synchronous Design.

UNIT IV DESIGN OF ARITHMETIC BUILDING BLOCKS 9

Data path circuits: Architecture for ripple carry adder, carry look ahead adder, high speed adder, accumulator, Multiplier, divider, Barrel shifter, speed and area tradeoff.

UNIT V SPECIFICATION USING VERILOG HDL 9

Design Methodologies – Modules – Instances – Test bench – Operators – Number Specification – Identifiers and Keywords – Data Types – Modules and Ports – Gate-Level Modeling - Dataflow Modeling – Behavioral Modeling: Structured Procedures, Procedural Assignments, Timing Controls, Conditional Statements, Multiway Branching, Loops, Sequential and Parallel Blocks. Structural gate level description of decoder, equality detector, comparator, priority encoder, half adder, full adder, Ripple carry adder, Behavioral modeling of "n" bit comparator, D flip-flop, T flip-flop, Structural modeling of Asynchronous counter, shift register, PRBS – Applications of FPGA.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Neil H.E. Weste, David Money Harris, "CMOS VLSI Design: A Circuits and SystemsPerspective", 4th Edition, Pearson, 2017.
2. Samir Palnitkar, "Verilog HDL, A Guide to Digital Design and Synthesis", 2nd Edition, Pearson Education, 2005.

REFERENCES

1. Jan M. Rabaey, Anantha Chandrakasan, Borivoje. Nikolic, "Digital Integrated Circuits: A Design perspective", 2nd Edition, Pearson, 2016.
2. M.J.S Smith, "Application Specific integrated circuits", Pearson Education, 2008. (5th reprint)
3. Jan Rabaey, Anantha Chandrakasan, B.Nikolic, "Digital Integrated Circuits: A Design Perspective", PHI, 2nd Edition, 2003.
4. D.A. Pucknell & K.Eshraghian, "Basic VLSI Design", PHI, 3rd Edition, 2003.
5. Wayne Wolf, "Modern VLSI design", Pearson Education, 3rd Edition, 2007.
6. Uyemura J.P, "Introduction to VLSI circuits and systems", Wiley, 2002.

19EE47E DSP BASED SYSTEM DESIGN L T P C

3 0 0 3

COURSE OUTCOMES

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

CO 1: classify the instruction sets of C2xx DSP Controller. (K2)
CO 2: discuss the various peripheral functions of DSP Controller. (K2)
CO 3: explain the Event Managers used in DSP Controller. (K2)
CO 4: demonstrate DSP Controllers based power electronics applications. (K2)
CO 5: determine the current trends in DSP system design. (K2)

UNIT I INTRODUCTION 9

TMS LC2407 DSP controller– Peripherals – Software tools – C2xx DSP Core and Code Generation – CPU and Instruction Set – Components of C2xx DSP Core – Mapping – Interface System Configuration–Memory – Programming using C2xx DSP Instruction Set.

UNIT II PERIPHERALS 9

General purpose Input/output (GPIO) Functionality – Multiplexing and Control Registers – Interrupt Hierarchy – Initializing and Servicing Interrupts in Software – A/D converter– PWM signal generation.

UNIT III EVENT MANAGERS 9

Event Manager (EV) – Interrupts – General Purpose (GP) Timers – Compare Units – Capture Units and Quadrature Encoded Pulse (QEP) Circuitry – General Event Manager Information

UNIT IV DSP BASED POWER ELECTRONICS APPLICATIONS 9

DC– DC Buck – Boost converters – Continuous and Discontinuous Conduction Mode – Interfacing DSP to Buck – Boost Converter – Interrupt Service Routine – Regulation Code Sequences – Space Vector PWM Technique – Principle of constant V/f control of induction motor – DSP implementation.

UNIT V RECENT TRENDS IN DSP SYSTEM DESIGN 9

FPGA – Features and families – Complementary Programmable Logic Device – DSP versus FPGA – VHDL programming – VHDL based controller design – Applications of FPGA – Signal and Image Processing.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Mitra, Sanjit Kumar, “Digital Signal Processing: a Computer Based Approach”, Tata McGraw Hill Private Limited, 2012.
2. Sen M Kuo, Woon .Seng. Gan, “Digital signal Processors–Architecture, implementation and applications”, Pearson Education, 2005.

REFERENCES

1. Avtar Singh and S. Srinivasan, “Digital Signal Processing”, Thomson Brooks, 2004.
2. Phil Lapsley, Bler, Sholam, E.A.Lee, “DSP Processor fundamentals”, IEEE Press, 1999.
3. Charles.D. Roth, “Digital System Design using VHDL”, 2008.
4. N. Mohan, T.M. Undeland, and W.P. Robbins, “Power Electronics: Circuits, Devices and Applications “, John Wiley & Sons, 2nd Edition, 1995.
5. Wolf Wayne, "FPGA Based System Design", Pearson Education, 2009.

19EE48E MICROCONTROLLER BASED SYSTEM DESIGN L T P C

3 0 0 3

COURSE OUTCOMES

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

CO1: To understand the basics and requirement of processor functional blocks. (K2)
CO2: Observe the specialty of RISC processor Architecture. (K2)
CO3: Incorporate I/O hardware interface of a processor-based automation for consumer application with peripherals. (K2)
CO4: Incorporate I/O software interface of a processor with peripherals. (K2)

CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in commercial embedded processors (K2)

UNIT I PIC MICROCONTROLLER 9

Architecture – memory organization – addressing modes – instruction set – PIC programming in Assembly & C –I/O port, Data Conversion, RAM & ROM Allocation, Timer programming, practice in MP-LAB.

UNIT II ARM ARCHITECTURE 9

Architecture – memory organization – addressing modes – The ARM Programmer's model -Registers – Pipeline - Interrupts – Coprocessors – Interrupt Structure

UNIT III PERIPHERALS OF PIC AND ARM MICROCONTROLLER 9

PIC: ADC, DAC and Sensor Interfacing –Flash and EEPROM memories. ARM: I/O Memory – EEPROM – I/O Ports – SRAM –Timer –UART - Serial Communication with PC – ADC/DAC Interfacing.

UNIT IV ARM MICROCONTROLLER PROGRAMMING 9

ARM general Instruction set – Thumb instruction set – Introduction to DSP on ARM – Implementation example of Filters

UNIT V DESIGN WITH PIC AND ARM MICROCONTROLLERS 9

PIC implementation - Generation of Gate signals for converters and Inverters - Motor Control – Controlling DC/ AC appliances – Home Automation - Stand alone Data Acquisition System – ARM Implementation - Simple ASM/C programs - Loops – Look up table- Block copy- subroutines - Smart Agriculture using IoT.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Steve Furber, "ARM system on chip architecture", Addision Wesley, 2010.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, John Rayfield "ARM System Developer's Guide Designing and Optimizing System Software", Elsevier 2007.

REFERENCES

1. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey "PIC Microcontroller and Embedded Systems using Assembly and C for PIC18", Pearson Education 2008.
2. John Iovine, "PIC Microcontroller Project Book", McGraw Hill 2000
3. William Hohl, '"ARM Assembly Language", Fundamentals and Techniques, 2009.
4. Rajkamal, "Microcontrollers Architecture, Programming, Interfacing & System Design, Pearson, 2012
5. ARM Architecture Reference Manual, LPC213x User Manual
6. www.Nuvoton.com/websites on Advanced ARM Cortex Processors.

19EE50E ADVANCED MICROPROCESSOR AND MICROCONTROLLER L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: explain the fundamental concepts of microprocessor architecture. (K2)
CO2: develop knowledge about high performance Pentium CISC architectures. (K2)
CO3: discuss about the ARM processors. (K2)
CO4: describe the concept of PIC microcontroller. (K2)
CO5: design and write simple programming using arduino. (K3)

UNIT I INTRODUCTION 9

Generic Architecture – Instruction Set – Addressing modes – Memory hierarchy – register file – Cache – Virtual memory and paging – Segmentation – Pipelining – Instruction level parallelism – Reduced instruction set – RISC versus CISC.

UNIT II PENTIUM CISC ARCHITECTURE 9

CPU Architecture – Bus Operations – Pipelining – Branch prediction – Floating point unit – Operating Modes – Paging – Multitasking – Exception and Interrupts – Instruction set – Addressing modes.

UNIT III ARM RISC ARCHITECTURE 9

Organization of CPU – Bus architecture – Memory management unit – Instruction set – Thumb Instruction set – Addressing modes – Programming.

UNIT IV PIC MICROCONTROLLER 9

CPU Architecture – Instruction set – interrupts – Timers – I2C Interfacing – UART – A/D Converter – PWM and introduction to C–Compilers

UNIT V INTRODUCTION TO ARDUINO 9

Architecture – Instruction set – Registers and memory access – Digital I/O – timers, Debugging – Pulse width modulation (PWM) – Serial communication – Interrupts – Design of Arduino based temperature monitor and control.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Barry.B.Breg, “The Intel Microprocessors Architecture, Programming and Interfacing”, Merrill, 2014.
2. B. P. Singh, Renu Singh, “Advanced Microprocessor and Microcontroller”, New Age International, 2008
3. John .B.Peatman, “Design with PIC Microcontroller”, Prentice Hall Private Limited, 2007.
4. Steve Furber, "ARM System–On–Chip Architecture”, Addison Wesley, 2001.

REFERENCES

1. Mike McRoberts, “Beginning arduino”, Apress; 2013.
2. Valvano, "Embedded Microcomputer Systems", Thomson Asia Private Limited, First Reprint, 2012

3. Gene .H.Miller, “Micro Computer Engineering”, Pearson Education, 2003.
4. James L.Antonakos, “An Introduction to the Intel family of Microprocessors", Pearson Education 1999.
5. James L. Antonakos, “The Pentium Microprocessor", Pearson Education, 1997.
6. Daniel Tabak, "Advanced Microprocessors”, Tata McGraw Hill Private Limited, 1995.

15EE52E REAL TIME OPERATING SYSTEMS L T P C
3 0 0 3

COURSE OUTCOMES

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

CO 1: recall the processes of general Operating systems. (K1)
CO 2: describe the basics concepts of RTOS. (K2)
CO 3: explain the Real time models and scheduling. (K2)
CO 4: distinguish the various interprocess functions in RTOS. (K2)
CO 5: demonstrate the applications of RTOS in various domains. (K3)

UNIT I REVIEW OF OPERATING SYSTEMS 9

Basic Principles – Structures – System Calls – Files – Processes – Design and Implementation of processes – Communication between processes –Distributed Operating system – Distributed scheduling.

UNIT II RTOS CONCEPTS 9

Need for RTOS – Advantage and Disadvantage – Multitasking–Non preemptive Kernels – Preemptive Kernels – Round Robin Scheduling–Task Priorities – Mutual Exclusion – deadlock – inter task Communication – Message Mailboxes–Message Queues–Interrupts.

UNIT III µC/OS II BASICS 9

Features–Goal – Kernel Structures: Task– Task States–Task Scheduling– Idle Task – Statistics Task– Interrupts – Clock Tick– Initialization. Task Management: Creating Tasks– Task Stacks–Stack Checking– Suspending Task– System Time.

UNIT IV RTOS INTERPROCESS FUNCTIONS 9

Message Mailbox Management: Creating a Mailbox–Waiting for a Message box–Sending Message to a Mailbox. Message Queue Management: Creating Message Queue–Deleting a Message Queue–Waiting for a Message at a Queue–Sending Message to a Queue– Flushing a Queue– Semaphores in µC/OS II.

UNIT V MEMORY MANAGEMENT AND RTOS APPLICATIONS 9

Memory Management: Memory Control Blocks– Creating Partition– Obtaining a Memory Block function –Returning a Memory Block function – Applications: Image Processing – Voice over IP – Control Systems.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Raj Kamal, "Embedded Systems– Architecture, Programming and Design" Tata McGraw Hill Private Limited, 2015.
2. Herma K., "Real Time Systems – Design for distributed Embedded Applications", Kluwer Academic, 2011.

REFERENCES

1. Charles Crowley, "Operating Systems–A Design Oriented approach" Tata McGraw Hill Private Limited, 1998.
2. C.M. Krishna, Kang, G.Shin, "Real Time Systems", Tata McGraw Hill Private Limited, 1997.
3. Raymond J.A.Bhur, Donald L.Bailey, "An Introduction to Real Time Systems", Prentice Hall Private Limited, 1999.
4. Mukesh Sighal and N G Shi "Advanced Concepts in Operating System", Tata McGraw Hill Private Limited, 2011.
5. Jean J. Labrosse, "Micro C/OS–II: The Real Time Kernal", CMP Books, 2nd Edition, 1998.

19EE53E AUTOMOTIVE ELECTRICAL AND ELECTRONICS L T P C
3 0 0 3

COURSE OUTCOMES

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

CO 1: distinguish the types of lighting system, batteries and accessories. (K2)
CO 2: describe the basics concepts of starting systems. (K2)
CO 3: explain the aspects of charging systems. (K2)
CO 4: explain the various processes in automotive electronics. (K2)
CO 5: develop the sensors and activators using Arduino. (K3)

UNIT I ELECTRICAL SYSTEMS 9

Principle and Construction of Lead Acid and Lithium-Ion Battery - Characteristics of Battery Rating Capacity and Efficiency of Batteries - Various Tests on Batteries - Maintenance and Charging - Lighting System and Photometry: insulated and Earth Return System- Details of Head Light and Side Light- LED Lighting System- Head Light Dazzling and Preventive Methods Horns- Wiper System.

UNIT II STARTING AND IGNITION SYSTEM 9

Condition at Starting- Behavior of Starter During Starting - Series Motor and Its Characteristics - Principle and Construction of Starter Motor - Over Running Clutch Working of Different Starter Drive Units - Care and Maintenances of Starter Motor - Starter Switches - Spark Plugs - Advance Mechanisms - Different Types of Ignition Systems.

UNIT III CHARGING SYSTEM 9

Generation of Direct Current - Shunt Generator Characteristics - Armature Reaction - Third Brush Regulation – Cutout - Voltage and Current Regulators - Compensated Voltage

Regulator Alternators Principle and Constructional Aspects and Bridge Rectifiers - New Developments.

UNIT IV ELECTRONICS SYSTEMS 9

Current Trends in Automotive Electronic Engine Management System - Types of EMS Electromagnetic interference Suppression - Electromagnetic Compatibility - Electronic Dashboard Instruments - Onboard Diagnostic System - Security - Warning System infotainment and Telematics.

UNIT V SENSORS AND ACTUATORS 9

Types of Sensors: Sensor for Speed - Throttle Position - Exhaust Oxygen Level - Manifold Pressure - Crankshaft Position - Coolant Temperature - Exhaust Temperature - Air Mass Flow for Engine Application – Solenoids - Stepper Motors – Relay - Introduction to Arduino about actuators and sensors.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Tom denton, “Automotive Electrical And Electronics Systems”, Allied Publishers, 2016.
2. A. L. Statini, “Automotive Electrical and Electronics”, Delmar Publications, 2013.

REFERENCES

1. William B.Ribbens “Understanding Automotive Electronics”, Butter worth Heinemann Woburn, 2017.
2. Robert Bosch “Automotive Hand Book”, SAE, 2018.
3. Ganesan.V. “Internal Combustion Engines”, Tata McGraw Hill Private Limited, New Delhi, 2017.
4. Young A.P. & Griffiths. L. “Automotive Electrical Equipment”, ELBS & New Press, 1999.
5. Bechhold “Understanding Automotive Electronics”, SAE, 1998.
6. Crouse, W.H “Automobile Electrical Equipment”, Tata McGraw Hill Private Limited, New York, 1996.
7. Judge A.W “Modern Electrical Equipment of Automobiles”, Chapman & Hall, London, 2012.
8. Robert N Brady, “Automotive Computers and digital Instrumentation”, Prentice Hall, Eagle Wood Cliffs, New Jersy,1988.
9. Vinal.G.W., “Storage Batteries”, John Wiley & Sons Inc., New York, 1985.
10. Tom Weather Jr and Cland C. Hunter, “Automotive Computers and Control System”, Prentice Hall Private Limited, New Jersey, 1996.
11. Kohli.P, “Automotive Electrical Equipment”, Tata McGraw Hill Private Limited, New Delhi, 2017.

19EE54E MOBILE ROBOTS AND CONTROL L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: study the different types of mobile robots and sensors onboard (K2)
CO2: develop the kinematic and dynamic models of mobile robotics.(K2)
CO3: examine the locomotion and navigation of robot with obstacle avoidance. (K2)
CO4: investigate the environment around robots using camera module. (K2)
CO5: apply kinematic and dynamic control for mobile robot application. (K2)

UNIT I MOBILE ROBOTS AND MANIPULATORS 9

Introduction: mobile robots & mobile manipulators – Locomotion - Types: Autonomous Ground Vehicle (AGV), aerial robots - Sensors: magnetic & optical position sensor, gyroscope, accelerometer, tactile & proximity sensors, rangefinder, laser scanner.

UNIT II MODELLING OF MOBILE ROBOTS 9

Wheeled mobile robot: Kinematics model – Degree of Freedom (DOF) – maneuverability - different wheel configurations -Generalized wheel model - holonomic and non-holonomic robots -Dynamics of mobile robot: Lagrange-Euler and Newton-Euler methods.

UNIT III NAVIGATION AND LOCALIZATION 9

Robot navigation – Localization: Error propagation model, Probabilistic map-based localization, Autonomous map building, Simultaneous localization and mapping (SLAM) - Motion and path planning: collision free path planning and sensor-based obstacle avoidance.

UNIT IV IMAGE PROCESSING FOR MOBILE ROBOT 9

Camera - Image representation–threshold – BLOB analysis - object recognition- noise and edges convolution masks-edge detection - Processing techniques – sematic segmentation

UNIT V CONTROL OF MOBILE ROBOT 9

Motion control of mobile robots - Motion controlling methods, kinematic control, dynamic control and cascaded control – Case study: QBOT 2 robot - wireless connected robot – agent control - Communication protocols.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. R Siegwart, IR Nourbakhsh, D Scaramuzza, Introduction to Autonomous Mobile Robots, MIT Press, USA, 2011.
2. Gregor Klancar, Andrej zdesar, Sasa Blazic, Igor Skrjanc, “Wheeled mobile robotics”, Elsevier, 2017.

REFERENCES

1. Eugene Kagan, Nir Shvalb, Irad Ben-Gal, “Autonomous Mobile Robots and Multi-Robot Systems: Motion-Planning, Communication, and Swarming” Wiley publication 2020.
2. SG Tzafestas, Introduction to Mobile Robot Control, Elsevier, USA, 2014.
3. A Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, USA, 2013.
4. S Thrun, W Burgard, D Fox, Probabilistic Robotics, MIT Press, USA, 2005.

5. G Dudek, M Jenkin, Computational Principles of Mobile Robotics, Cambridge University Press, USA, 2010.
6. https://onlinecourses.nptel.ac.in/noc21_me44/preview

19EE55E ELECTRIC VEHICLE MACHINES AND DRIVES L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: Understand the fundamentals on electric and hybrid vehicles. (K2)
CO2: Analyze the operation of DC and AC motor drives. (K2)
CO3: Explain the configurations and design of permanent magnet brushless and switched reluctance motor drives. (K2)
CO4: Explain the configurations and design of stator-permanent magnet, magnetic-geared and vernier permanent magnet motor drives. (K2)
CO5: Discuss the advanced motor drives in Electric Vehicle. (K2)

UNIT I INTRODUCTION 9

Overview of conventional vehicle drive system and issues – Introduction to Electric Vehicle (EV) Pure Electric Vehicle - Hybrid Electric Vehicle - Gridable Hybrid Electric Vehicle – Fuel Cell Electric Vehicle - Overview of EV Technologies: Motor Drive Technology - Energy Source Technology - Battery Charging Technology -Vehicle-to-Grid Technology.

UNIT II DC AND AC MOTOR DRIVES 9

DC Machines: An Overview - Soft-Switching DC–DC Converter Topologies - Design Criteria of DC series Motor Drives for EVs with application examples - Induction Machines: An Overview - Inverters for Induction Motors: PWM Switching Inverters, Soft-Switching Inverters - Design Criteria of Induction Motor Drives for EVs with application examples.

UNIT III PERMANENT MAGNET BRUSHLESS AND SWITCHED RELUCTANCE MOTOR DRIVES 9

Permanent Magnet Brushless DC Motor (PMBLDC): Overview - Inverters for PMBLDC Motors: Inverter Requirements, Switching Schemes for Brushless AC and DC Operation - Design Criteria of PMBLDC Motor Drives for EVs with application examples. Switched Reluctance Motor (SRM): Overview - Comparison of Converters for SRM drives - Design Criteria of SRM Drives for EVs.

UNIT IV STATOR-PERMANENT MAGNET, MAGNETIC-GEARED AND VERNIER PERMANENT MAGNET MOTOR DRIVES 9

Overview of Stator Permanent Magnet (PM) motor - Doubly-Salient PM Motor Drives - Hybrid-Excited PM Motor Drives - Design Criteria of Stator-PM Motor Drives for EVs - Magnetic-Geared (MG): System Configurations, MG Machines, Inverters for MG Motors, Vernier Permanent Magnet: System Configurations, Vernier PM Machines, Inverters for Vernier PM Motors.

UNIT V ADVANCED MOTOR DRIVES 9

Advanced Magnet less Motor Drives: System Configurations, Flux-Switching DC and Axial-Flux magnet less Motor Drives - Design Criteria of Advanced magnet less Motor Drives for EVs - Integrated-Starter-Generator Systems - System Configurations, Design Criteria and its application on EVs.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Denton, Tom. Electric and hybrid vehicles. Routledge, 2020.
2. Hughes, Austin, and Bill Drury. Electric motors and drives: fundamentals, types and applications. Newnes, 2019.
3. Neapolitan, Richard E., and Kwang Hee Nam. AC motor control and electrical vehicle applications. CRC press, 2018.

REFERENCES

1. Emadi, Ali, ed. Advanced electric drive vehicles. CRC Press, 2014.
2. Electric Vehicle Machines and Drives Design, Analysis and Application, K.T.Chau, John Wiley & Sons Private Limited, Singapore, 2015

19EE56E BATTERY MANAGEMENT SYSTEMS AND MODELING L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: Understand the different types of batteries. (K2)
CO2: Analyze the efficiency and capacity of vehicle batteries. (K2)
CO3: Explain the various factors associated to battery management systems. (K2)
CO4: Compute the state of charge and state of health estimation of EV batteries. (K2)
CO5: Discuss the testing and safety requirements of the battery. (K2)

UNIT I INTRODUCTION TO BATTERIES 9

Battery basics - Fuel Cell Technology - super capacitors – Applications: Electric Vehicle - Choice of a Battery Type for Electric Vehicles –equivalent circuit model.

UNIT II BATTERY EFFICIENCY AND CAPACITY 9

Effects of valve regulated lead–acid (VRLA) Battery - Battery Storage - Lithium-ion Battery - Traction Battery Pack Design - Battery efficiency and Capacity - Temperature Dependence of Battery Capacity - State of Charge of a VRLA, lithium Battery - Li-ion Battery Capacity - Energy Balances for the Electric Vehicle - Electric Vehicle Battery Charging and Discharging - Electric Vehicle Battery Performance.

UNIT III BATTERY MANAGEMENT SYSTEM (BMS) REQUIREMENTS 9

Battery-pack topology - BMS design requirements - Battery-pack sensing: voltage, current, temperature - Isolation sensing - Charger control - State of charge estimation - Power estimation –Modeling of battery cells – Simulation of battery packs.

UNIT IV BATTERY-STATE ESTIMATION AND HEALTH ESTIMATION 9

SOC estimation - approaches to estimate SOC - linear Kalman filter - Implementing an EKF using the ESC cell model - Real-world issues pertaining to sensors, initialization - Need for health estimates - Negative-electrode aging - Positive-electrode aging - Robustness and speed - Code to simulate the methods - Example EV simulations.

UNIT V TESTING AND SAFETY REQUIREMENTS OF BATTERY 9

Cell Balancing - Voltage-Based Power-Limit Estimation - Testing of Batteries: Cell / Module / Pack level testing - Accelerated Reliability Testing of Electric Vehicles - Battery Cycle Life versus Peak Power and Rest Period - Safety Requirements for Electric Vehicle Batteries – EV charging station - Battery disposal and recycling techniques.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. The 2021-2026 World Outlook for Battery Management Systems (BMS), Prof Philip M. Parker – 2020.
2. Shunli Wang, Carlos Fernandez, Yu Chunmei, Fan Yongcun, Cao Wen, Daniel-Ioan Stroe, Zonghai Chen. Battery System Modeling, Elsevier 2021.
3. Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods. Artech House, 2015.
4. Pop, Valer, Henk Jan Bergveld, Dmitry Danilov, Paul PL Regtien, and Peter HL Notten. Battery management systems: Accurate state-of-charge indication for battery-powered applications. Vol. 9. Springer Science & Business Media, 2008.
5. Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015.

REFERENCES

1. Link, Albert, Alan O'Connor, and Troy Scott. Battery Technology for electric vehicles: Public science and private innovation. Routledge, 2015.
2. Dhameja, Sandeep. Electric vehicle battery systems. Elsevier, 2001.

19EE57E CONTROL OF HYBRID ELECTRIC VEHICLES L T P C

3 0 0 3

COURSE OUTCOMES

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

CO1: Understand the layouts of hybrid electric vehicles (HEVs). (K2)
CO2: Explain the basic components of hybrid electric vehicles. (K2)
CO3: Analyze the modeling of hybrid vehicle systems. (K2)
CO4: Analyze the power electronics and electric motor drive control. (K2)
CO5: Derive the energy storage system modeling and control. (K2)

UNIT I INTRODUCTION 9

Classification of Hybrid Electric Vehicles - General Architectures of Hybrid Electric Vehicles - Typical Layouts of Hybrid Electric Systems - Hybrid Electric Vehicle System

Analysis: Power Flow, Fuel Economy Benefits, Typical Drive Cycles, Vehicle Drivability - Controls of Hybrid Electric Vehicles.

UNIT II BASIC COMPONENTS OF HYBRID ELECTRIC VEHICLES 9

Prime Mover - Electric Motor with a DC–DC Converter and a DC–AC Inverter - Energy Storage System: Energy Storage System Requirements for Hybrid Electric Vehicles - Basic Types of Battery for Hybrid Electric Vehicle System Applications - Transmission System in Hybrid Electric Vehicles.

UNIT III HYBRID VEHICLE SYSTEM MODELING 9

Modeling of Internal Combustion Engine - Modeling of Electric Motor: BLDC and AC induction motors - Modeling of Battery System - Modeling of Transmission System: Clutch and Power Split Device, Torque Converter, Gear Box, Transmission Controller - Modeling of Final Drive and Wheel - PID-Based Driver Model.

UNIT IV POWER ELECTRONICS AND ELECTRIC MOTOR DRIVE CONTROL 9

Basic Power Electronic Devices - DC/DC Converter: basic Principle of operation, and closed loop PID controller design - DC–AC Inverter: Operation, closed loop PID controller design - Electric Motor Drives: BLDC motor and control.

UNIT V ENERGY STORAGE SYSTEM MODELING AND CONTROL 9

Introduction - Methods of Determining the State of Charge - Estimation of Battery Power Availability - Battery Life Prediction - Cell Balancing - Estimation of Cell Core Temperature - Plug-In Battery Charger Design - Battery Protection and control - Case study.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Taghavipour, Amir, Mahyar Vajedi, and Nasser L. Azad. Intelligent control of connected plug-in hybrid electric vehicles. Springer International Publishing, 2019.
2. Guo, Zhiqiang, and Deshang Sha. New Topologies and Modulation Schemes for Soft-switching Isolated DC-DC Converters. Springer, 2020.
3. Rahman, Md Ashib, Md Rabiul Islam, Kashem M. Muttaqi, and Danny Sutanto. "Modeling, Design, and Control of Solid-State Transformer for Grid Integration of Renewable Sources." In Emerging Power Converters for Renewable Energy and Electric Vehicles, pp. 1-36. CRC Press, 2021.

REFERENCES

1. Barbi, Ivo, and Fabiana Pottker. Soft Commutation Isolated DC-DC Converters. Vol. 1. Springer International Publishing, 2019.
2. Soylu, Seref, ed. Electric vehicles: modelling and simulations. BoD–Books on Demand, 2011.
3. Liu, Wei. Hybrid electric vehicle system modeling and control. John Wiley & Sons, 2017.

19EE58E AUTONOMOUS INTELLIGENT VEHICLES L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: Explain the basic components of autonomous vehicle. (K2)
CO2: Discuss the role of control in autonomous systems. (K2)
CO3: Describe the system architecture and sensors. (K2)
CO4: Explain the maps and path planning for Autonomous electric vehicle. (K2)
CO5: Review the recent research on autonomous systems. (K2)

UNIT I AUTONOMOUS VEHICLE 9

Introduction - Background in Autonomy in Cars - Components of Autonomy - Autonomous Vehicle Operational Models - Automated Driving Levels - Operating Models Comparison - Research and Experiments on Autonomous Vehicles (Case study).

UNIT II THE ROLE OF CONTROL IN AUTONOMOUS SYSTEMS 9

Introduction – feedback: Speed Control Using Point Mass and Force Input, Stopping, Swerving - Car Following and Advanced Cruise Control - Steering Control Using Point Mass Model: Open-Loop Commands - Steering Control Using Point Mass Model: Closed-Loop Commands.

UNIT III SYSTEM ARCHITECTURE AND SENSORS 9

System Architecture - Hybrid System Formulation - State Machines for Different Challenge Events – Sensors: Proximity sensors - Sensor Characteristics - Vehicle Internal State Sensing: Pressure and temperature sensors, Global positioning system, inertial measurements - External World Sensing: Image processing sensors, LIDAR – Estimation - Sensor Fusion - Track Classification - Antilock-Brake Systems - Steering Control and Lane Following – Parking.

UNIT IV MAPS AND PATH PLANNING 9

Map Databases - Path Planning - radar tracking system -Vehicle-to-Vehicle Communication (V2V) - Vehicle-to-Infrastructure Communication (V2I) - The Panoramic Imaging Model.

UNIT V RECENT RESEARCH – A REVIEW 9

Advancement in Autonomous electric vehicle (AUEV) – Global challenges related to AUEV system – comparison of autonomous electric vehicles and electric vehicle: Benefits, cost, performance, life cycle etc.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Yu, Huafeng, Xin Li, Richard M. Murray, S. Ramesh, and Claire J. Tomlin, eds. Safe, Autonomous and Intelligent Vehicles. Springer, 2018.
2. Hanky Sjafrie, Introduction to Self-Driving Vehicle Technology (Chapman & Hall/CRC Artificial Intelligence and Robotics Series), CRC Press 2020.

3. Adouane, Lounis. Autonomous vehicle navigation: from behavioral to hybrid multi-controller architectures. CRC Press, 2016.
4. Bizon, Nicu, Lucian Dascalescu, and Naser Mahdavi Tabatabaei, eds. Autonomous vehicles: intelligent transport systems and smart technologies. Nova Science Publishers, 2014.

REFERENCES

1. Nonami, Kenzo, Muljowidodo Kartidjo, K. Yoon, and Agus Budiyono. "Autonomous control systems and vehicles." Intelligent Systems, Control and Automation: Science and Engineering 65 (2013).
2. Ozguner, Umit, Tankut Acarman, and Keith Alan Redmill. Autonomous ground vehicles. Artech House, 2011.
3. Fazlollahtabar, Hamed, and Mohammad Saidi-Mehrabad. Autonomous guided vehicles. Vol. 20. Springer Science and Business Media LLC: Cham, Switzerland, 2015.
4. Cheng, Hong. Autonomous intelligent vehicles: theory, algorithms, and implementation. Springer Science & Business Media, 2011.

19EE59E ELECTRONICS DESIGN AND TECHNOLOGY L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: use the electrical components in an application circuit (K3)
CO2: implement the application circuit of the semiconductor devices. (K3)
CO3: Describe the op-amp application circuits (K2)
CO4: Explain the digital concepts with its design and application (K2)
CO5: implement the power supply circuits using electronics technology (K3)

UNIT I BASIC CIRCUITS 9

Resistor, Inductor, Capacitor - Types – selection, ratings - power calculation – Reactance - Data sheet approach – Review of Network Reduction (R/L/C) - Energy stored - Star delta conversion- RC, LC circuits – Filters - Voltage and Current Division Resistance Inductance Capacitor Behavior in AC and DC Circuits – Transient Characteristics - Applications of Network Theorems - DC sources – Battery - Serial and Parallel - AH calculations – Ohm meter concepts – Ammeter – Voltmeter– internal resistance - Range modification - shunt calculation – PWM for Variable DC concepts

UNIT II SEMICONDUCTOR DESIGN 9

Review of Diode Circuits – Design of wave shaping circuits – Zener voltage regulator, threshold, Power and Resistor design –Limiter – BJT- gain in various configuration - region of operation, cutoff and saturation – load line - V/I calculation for various region of operation- simple circuits design – Darlington as buffer – datasheet - BJT as switch - Relay interfacing – BJT JFET comparison – JFET circuits Design – variation in channel

resistance – MOSFET – Operating Region – different circuits design – Current Mirrors - LED driver design- opto coupler design

UNIT III OP-AMP APPLICATIONS 9

Review of Op-amp characteristics – Open loop, closed loop concepts –positive and Negative feedback - importance of a Buffer- sensor interfacing – Application circuits of amplifier, summer, integrator/differentiator, comparator with AC/DC inputs, and sine to square converter – precision rectifiers – peak detector – S&H circuits - Application circuits of First order LPF, HPF, BPF, BRF – compensation –Slew rate – clock and delay generating circuits - ADC concepts review, Resolution

UNIT IV DIGITAL DESIGN 9

Review of Number system and Conversion - Gates formation using Diode, Transistor and MOSFET, Universal Gates – Difference Conversion - CMOS and TTL concepts - Application circuits of Gates – Application circuits of Flip flop – Counters – design of Mod Counter - Application of Adder subtractor – Mux and Demux Concepts – Serial communication – SPI I2C protocols and its concepts – Clock generation circuits – high precision oscillators – Latch Buffer – Edge level triggering – DAC concepts

UNIT V POWER SUPPLY 9

Design of Rectifier Circuits – Output voltage, power calculations – Selection of devices – Filters design – EMI suppressor – Metal oxide varistor – Need of Regulator - Design of complete LMPS with regulator – Fixed Regulator ICs – Design of Variable power supply – HF ripple reduction techniques – signal and power supply ground – SMPS – Block diagram – importance – difference between LMPS and SMPS – Fast Recovery Devices - Schottky diode – ESR concepts – DC to DC simple circuits.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Sudhakar A and Shyam Mohan SP, “Circuits and Network Analysis and Synthesis”, Tata McGraw- Hill, New Delhi, 2007.
2. Robert L. Boylestad and Louis Nashelsky, “Electronic Devices and Circuit Theory”, 10th Edition, Prentice Hall, 2009.
3. Millman and Halkias. C., “Integrated Electronics”, Tata McGraw-Hill, 2010 (Reprint).
4. Thomas L. Floyd, “Digital Fundamentals”, 10th Edition, Pearson Education Inc, New Delhi, 2009.

REFERENCES

1. Keith H.Billings, “Switchmode Power Supply Handbook”, McGraw-Hill Professional, 3rd Edition, 2010.
2. S.Salivahanan, N. Suresh Kumar and A.Vallavaraj, “Electronic Devices and Circuits”, 3rd Edition, TMH, 2012.
3. Donald D.Givone, “Digital Principles and Design”, Tata Mc-Graw Hill Publishing company limited, New Delhi, 2003.

R – 2019 B.E - EEE

ONE CREDIT ELECTIVE COURSES

19EE01L DESIGN OF POWER CONVERTERS LABORATORY L T P C
0 0 2 1

COURSE OUTCOME

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

CO1: design and construct the various types of power converters. (K2)

LIST OF EXPERIMENTS

1. Single phase controlled rectifiers.
2. Three phase controlled rectifiers.
3. Step-down and step-up dc choppers.
4. Buck/boost converters.
5. Single phase voltage source inverter.
6. Three phase voltage source inverter.
7. Ac voltage controllers.
8. Two stage sequence control of ac voltage controller.
9. Step up cycloconverter.
10. Step down Cycloconverter.

P: 30 TOTAL: 30 PERIODS

19EE02L ENERGY STORAGE SYSTEM L T P C
1 0 0 1

COURSE OUTCOMES

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

CO1: understand the operational mechanisms of each energy storage system (K2)

CO2: characterize and analyze electrochemical energy storages (K3)

COURSE CONTENT

Energy storage overview - Thermodynamics - Rechargeable Batteries and their Fundamental Electrochemistry - Li-ion Battery Technology and Challenges - Cathode and Anode Materials - Electrolytes - Fuel cell / regenerative fuel cell - Super-capacitor - Reaction kinetics - Electrochemical characterization - Introduction to Super Conducting Magnetic Energy Storage (SMES) operation - Load Leveling - Frequency Regulation - Power Quality - Applications.

L: 15 TOTAL: 15 PERIODS

REFERENCES

1. Robert A. Huggins, “Energy Storage”, Springer Science and Business Media, 2010.
2. Ryan O"Hayre, Suk-Won Cha, Whitney Colella and Fritz B. Prinz, “Fuel Cell Fundamentals”, Wiley, 3rd Edition, 2016.
3. A.G.Ter-Gazarian, “Energy Storage for Power Systems”, 2nd Edition, IET Publications, 2011.

19EE03L **LVDC WIRING** **L T P C**
1 0 0 1

COURSE OUTCOMES

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

CO1: describe the fundamental knowledge in electrical engineering (K2)

CO2: prepare the details of estimation for residential and commercial electrical installations (K3)

COURSE CONTENT

Electrical symbols - DC Source (solar panel) - Voltage levels in DC supply - Types of storage device - DC Appliances : CFL, LED bulbs/TV, Vacuum cleaners, Computers, Mobile chargers, DC Ceiling fans(muffin fans), DC Refrigerators - DC wirings(PoE) - Switches and relays (solid state DC circuit breakers) - DC sockets - Safety practices – Advantages.

L: 15 TOTAL: 15 PERIODS

REFERENCES

1. S.L. Uppal, “Electrical Estimating and costing”, New Age International Pvt. Ltd., 2014.
2. J.B. Gupta, “Electrical Installation estimating and costing”, S. K. Kataria and Sons, New Delhi, 15th Edition 2016.
3. Relevant IS Code for - Service Line Connection, Lying of Cable, Wiring Installation, National Building Code - Vol. 4.
4. https://www.allaboutcircuits.com/textbook/direct-current/
5. http://hackaday.com/2017/03/06/what-voltage-for-the-all-dc-house/
6. http://www.edn.com/electronics-blogs/dave-s-power-trips/4402704/How-do-we-get-to-a DC-powered-home
7. http://chrisgammell.com/can-dc-power-an-entire-home/
8. http://www.backwoodssolar.com/when-to-use-dc-appliances
9. http://www.treehugger.com/sustainable-product-design/big-steps-in-building-change-our-wiring-to-12-volt-dc.html

19EE04L **DIGITAL SUBSTATION** **L T P C**
1 0 0 1

COURSE OUTCOMES

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

CO1: describe the architecture of a digital substation (K2)

CO2: explain the importance of intelligent electronic devices (K2)

COURSE CONTENT

Introduction to digital substation - Power system automation - Modern grid and substation automation - System architecture - Components of digital substation - IEC 61850 substation architecture - Intelligent Electronic devices - Station and process bus - GPS time clock - Merging units - Electronic fibre optic CT and VT - Working of a digital substation - Security threats - Advantages of digital substation.

L: 15 TOTAL: 15 PERIODS

REFERENCES

1. Evelio Padilla, "Substation Automation Systems: Design and Implementation", Wiley, 2015.
2. Cobus Strauss, "Practical Electrical Network Automation and Communication Systems", Elsevier, 1st Edition, 2003.
3. http://myelectrical.com/notes/entryid/245/how-a-digital-substation-works
4. store.gedigitalenergy.com/faq/documents/general/iec61850.pdf

19EE05L ELECTRICAL SYSTEM FOR SMART BUILDING L T P C
1 0 0 1

COURSE OUTCOMES

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

CO1: understand the basic features of intelligent buildings (K2)

CO2: understand the operating principle and characteristics of various service Systems / technologies (K2)

COURSE CONTENT

Introduction to Intelligent Buildings - Basic Concepts - Intelligent Building Automation - Introduction to Smart Materials - HVAC (Heating, Ventilation And Air-Conditioning) Systems - Electrical Installations - Lighting Systems - Security and safety systems - Intelligent vertical transportation systems - Communication Systems - Structured cabling systems - Electrical Power Quality In Buildings - EMI/EMC Issues - Grounding Problems - Overview of Home/Building Automation - Case studies.

L: 15 TOTAL: 15 PERIODS

REFERENCES

1. Derek Clements and Croome, "Intelligent Building Design, Management and Operations", Thomas Telford Publishing, London, 2004.
2. Derek Clements and Croome, "Intelligent Buildings: An Introduction", Routledge,2014
3. Shengwei Wang**,** "Intelligent Buildings and Building Automation", Spon Press, London, 2010.
4. P. Manolescue, "Integrating Security into Intelligent Buildings", Cheltenharn, 2003.
5. Albert Ting – Pat So and Wai Lok Chan, "Intelligent Building Systems", Kluwer Academic Publisher, U.S.A, 1999.
6. C. Ehrlich, "Intelligent Building Dictionary: Terminology for Smart, Integrated, Green Building Design, Construction, and Management" San Francisco, Calif: Hands-on-Guide, 2007.
7. www.ieindia.org,www.koetterfire.com, www.informit.com

19EE06L POWER SYSTEM PROTECTION AND SUBSTATION AUTOMATION L T P C
1 0 0 1

COURSE OUTCOMES

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

CO1: describe the protection schemes of electrical apparatus (K2)

CO2: explain the structure of substation automation system (K2)

COURSE CONTENT

Introduction to power system protection - Protection of generators and motors - Protection of transformers and reactors - Protection of transmission lines - Circuit breaker protection and monitoring - Introduction to substation integration and automation system - Functional architecture - Substation automation: Distributed structure, Centralized structure - Substation integration and automation technical issues.

L: 15 TOTAL: 15 PERIODS

REFERENCES

1. Badri Ram and D. N.Vishwakarma, “Power System Protection and Switchgear”, Tata McGraw Hill, 2nd Edition, 2011.
2. Cobus Strauss, “Practical Electrical Network Automation and Communication Systems”, Elsevier, 1st Edition, 2003.
3. Evelio Padilla, “Substation Automation Systems: Design and Implementation”,Wiley, 2015.

19EE07L ENERGY LABORATORY L T P C
0 0 2 1

COURSE OUTCOME

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

CO1: Design the renewable energy system for given application by collecting the field data.(K3)

LIST OF EXPERIMENTS

1. Design and estimation of solar radiation transmission through glazing materials in solar collector.
2. Design the solar photovoltaic systems and predict the array yield, final yield and performance ratio of the systems.
3. Design the battery backup system for domestic application by investigating the charging and discharging characteristics of battery.
4. Design the Anaerobic digester for organic waste generated from community buildings through research of literature.
5. Design the small scale wind energy systems for a location by collecting metrological data.
6. Design and investigate the performance of solar water heating system for the residential building.

P: 30 TOTAL: 30 PERIODS

19EE08L HVDC CIRCUIT BREAKERS L T P C
1 0 0 1

COURSE OUTCOMES

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

CO1: understand the modern trends used in HVDC circuit breakers (K2)

CO2: explain the characteristics of HVDC circuit breakers (K2)

COURSE CONTENT

Introduction to HVDC Circuit Breakers - Construction - Principle – Comparison between HVAC and HVDC Circuit Breakers - IGBT Based Switching - Switching Energy - Interruption of DC Current - Type of HVDC Circuit Breakers - Capability and Characteristics of HVDC Circuit Breaker - Requirements of HVDC Circuit Breakers – Applications, Advantages and Disadvantages of HVDC Circuit Breakers.

L: 15 TOTAL: 15 PERIODS

REFERENCES

1. K.R. Padiyar, "HVDC Power Transmission Systems", New age international publications, 3rd Edition, 2017
2. P. Kundur, "P.S. Stability and Control", Tata McGraw Hill, 1994
3. C.L. Wadhwa, "Electrical Power Systems", New age International Pvt. Ltd., 6th Edition, 2010

19EE09L EARTHING DESIGN L T P C
1 0 0 1

COURSE OUTCOMES

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

CO1: describe the earthing system design (K2)

CO2: explain the various types of earthing in substations (K2)

COURSE CONTENT

Factors Influencing the Choice of Earthed and Unearthed Systems - System Earthing - Substation Earthing/Grounding - Power Frequency Earthing - High Frequency Earthing - Touch and Step Potential - Surge Phenomenon and Suppression Techniques - Earthing In Substations - Earthing Associated With Overhead Power Lines- Calculation of Earth Fault Currents - Measurement of Earth Resistivity, Electrode Resistance, Earth Loop Impedance.

L: 15 TOTAL: 15 PERIODS

REFERENCES

1. Institute of Electrical and Electronics Engineers, IEEE Guide for Safety in AC Substation Grounding, IEEE standard 80 – 2000.
2. Maneesh Kumar and Gagandeep Singh, "Design of Grounding System for an Electrical Substation: An Overview", International Journal of Scientific & Engineering Research, Vol. 5, No. 11, pp. 246-248 November 2014.

19EE10L ALTERNATE INSULATING MEDIUM L T P C
1 0 0 1

COURSE OUTCOMES

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

CO1: identify the various insulating materials. (K2)

CO2: explain the structure of fluoroketone based gas mixture. (K2)

COURSE CONTENT

Introduction to Insulating Medium - Overview of Solid, Liquid, Gas And Vacuum medium -

Performance and Environmental Issues of Existing Dielectric Medium - Global warming potential (GWP) - Need For Alternate Insulating Medium - SF_6 - Advantages And Disadvantages - Identification Of New Gases - A Fluoroketone Based Gas Mixture - Properties - Dielectric Performance - Thermal Performance - Long-Term Behavior - Life-Cycle Assessment (LCA) - Benefits - Future Grid Carbon Footprint - alternate esteroids.

L: 15 TOTAL: 15 PERIODS

REFERENCES

1. P.Simka and N.Ranjan, "Dielectric Strength of C_5 Perfluoroketone," in 19th International Symposium on High Voltage Engineering, Pilsen, Czech Republic, 2015.
2. J. C. Devins, "Replacement gases for SF_6," IEEE Transactions on Dielectric Electrical Insulation, Vol. 15, pp. 81– 86, 1980.
3. ABB review 2016 in AirPlus™
4. Maik Hyrenbach, Tobias Hintzen, Pascal Muller and John Owens, "Alternative insulation gas for medium-voltage switchgear", 23rd International Conference on Electricity Distribution Lyon, June 2015.
5. J.D. Mantilla, N. Gariboldi, S. Grob and M. Claessens, "Investigation of the Insulation Performance of a New Gas Mixture with Extremely Low GWP", IEEE Electrical Insulation Conference, pp. 469-473, 2014.

19EE11L COMMUNICATION TECHNOLOGIES FOR SMART GRIDS L T P C
1 0 0 1

COURSE OUTCOMES

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

CO1: explain the communication channels and protocols for smart grid (K2)

CO2: describe the standards of smart grid communication (K2)

COURSE CONTENT

Introduction - Data communication -Communication channels - Communication/networking architecture - Smart Grid architecture - Internet based architecture - Power Line Communication architecture - Wireless Communication technologies - IEEE 802 series - Other issues in communication/networking - Challenges and research directions.

L: 15 TOTAL: 15 PERIODS

REFERENCES

1. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, and Nick Jenkins, "Smart Grid Technology and Applications", A John Wiley and Sons Ltd. Publication, 1st Edition, 2012.
2. James Momoh, "Smart Grid: Fundamentals of Design and Analysis", A John Wiley and Sons Ltd. Publication, 2012.
3. Jingcheng Gao, Wei Liang, Yang Xiao and C. L. Philip Chen, "A survey of communication/ networking in Smart Grids", Future Generation Computer Systems, Vol. 28, No. 2, pp. 391-404, February 2012.

19EE12L NON-CONVENTIONAL INSTRUMENT TRANSFORMER L T P C
1 0 0 1

COURSE OUTCOMES

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

CO1: describe the structure and operation of non conventional instrument transformer (NCIT). (K2)

CO2: explain the measurements in real time applications by non conventional instrument transformer (NCIT). (K2)

COURSE CONTENT

Introduction to NCIT - Need of NCIT - Comparison of conventional Instrumentation transformer and NCIT - NCIT structure - Extended Merging Unit - NCIT operation - Measurements: HV laboratory - real operation states - NCIT in gas insulated switchgear - Advantages of NCIT.

L: 15 TOTAL: 15 PERIODS

REFERENCES

1. ABB Product Guide: Difference between Sensors and conventional Instrument Transformers.
2. Non-conventional instrument transformers: Advanced GIS substations with IEC 61850-9-2 LE process bus.
3. IEEE PES ELK-CP 050602_R0-5.ppt : Non-Conventional Instrument Transformers.
4. Holger Heine, Patrice Guenther and Farel Becker, “New Non Conventional Instrument Transformer (NCIT) – A future technology in Gas Insulated Switch Gear”, IEEE Conference on Transmission and Distribution and Exposition (T&D), May 2016.
5. Jure Mocnik, Janez Huma and Andrej Zemva, “A non-conventional instrument transformer”, Measurement, Elsevier, Vol. 46, No. 10, pp. 4114-4120, December 2013.

19EE13L INDUSTRIAL CONTROLLERS LABORATORY L T P C
0 0 2 1

COURSE OUTCOMES

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

CO1: articulate the PLC programming for Industrial processes. (K3)

CO2: implement the performance of controller in DDC and DCS. (K2)

LIST OF EXPERIMENTS

1. Design of Electronic On/Off controller with relay concept
2. Implementation of On Off controller using NI DAQ
3. Micro-processor based temperature control system
4. Batch process control by Programmable Logic Controller
5. PLC controlled level process
6. Reaction vessel control using Programmable Logic Controller
7. Traffic light control Using Programmable Logic Controller
8. Bottle filling system controlled by Programmable Logic Controller

9. Computer controlled Closed loop response of Temperature process
10. Computer controlled Closed loop response of pressure process
11. Monitor and Control of Temperature Process using SCADA with PLC
12. Implementation of Controller for Pressure and Temperature process in Distributed Control system
13. Automation of the Cement Plant, Sugar and Beverage Plant using Distributed Control system

P: 30 TOTAL: 30 PERIODS

19EE14L SOFT COMPUTING FOR ELECTRICAL ENGINEERING LABORATORY **L T P C 0 0 2 1**

COURSE OUTCOMES

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

CO1: implement various structures of ANN to system identification and control of linear and nonlinear systems. (K3)

CO2: develop program with fuzzy relationship to control electrical drives. (K3)

CO3: employ GA to power system optimization and control problems. (K3)

LIST OF EXPERIMENTS

1. Implement Discrete Hopfield Network and Test for Input Pattern.
2. Implement Adaline with Bipolar Inputs and Outputs
3. Implement Back Propagation Network for a Given Input Pattern.
4. Implement Composition of Fuzzy and Crisp Relations.
5. Perform max-min composition of two matrices obtained from cartesian product.
6. System identification using neural network
7. Controlling linear and nonlinear dynamic systems using neural network
8. Short term load forecasting using neural network
9. Implement the fuzzy logic controller for motor drives
10. Economic dispatch problem using GA
11. Load scheduling problem using GA
12. Unit commitment problem using GA
13. PID controller tuning using GA
14. System identification using GA

P: 30 TOTAL: 30 PERIODS

19EE15L ELECTRONICS FOR SAFETY CRITICAL SYSTEM **L T P C 1 0 0 1**

COURSE OUTCOMES

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

CO1: describe the standards of safety critical system (K2)

CO2: explain the development of electronics and software tools with respect to safety critical system. (K2)

COURSE CONTENT

Introduction to safety critical system - Need for safety critical systems - Integrity level and standard for safety critical system - Specification and Design - Verification - Commercial and Industrial Standards for Electrical Appliances - Grounding Techniques in Electrical / Electronics, ESD Protection, Need of Redundancy in Critical Applications to Avoid Risks - Single point failures- Elimination of Hazard / Risk Analysis - Basics of Reliability Analysis - Fault tree analysis - Failure mode effective analysis.

L: 15 TOTAL: 15 PERIODS

REFERENCES

1. An Introduction to Safety Critical Systems, www.qa-systems.com
2. G.R. Nisha, “A model driven approach for design and development of a safety critical system”, IEEE 2011 3rd International Conference on Electronics Computer Technology (ICECT) - Kanyakumari, India, 2011.
3. Ashok N. Srivastava and Johann Schumann, “Software Health Management: A Necessity for Safety Critical Systems”, Journal of Innovations in Systems and Software Engineering, Vol. 9, No. 4, pp. 219-233, 2013.
4. MIL STD 217 / 217 Plus, MIL STD 1629, for Reliability and FMEA / FMECA.

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19EE16L PCB DESIGN AND FABRICATION L T P C

0 0 2 1

COURSE OUTCOMES

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

CO1: design and analyze the Printed Circuit Boards fabrication. (K2)

CO2: develop the Printed Circuit Boards and discuss the factors affecting PCB performance. (K3)

COURSE CONTENT

Introduction to PCB design - Basics of hardware and software - Types of PCB, terminologies, PCB Layers - Different tools and software used for PCB designing - Different circuit on PCB design software - Creating a new project Building parts and symbols - Schematic of Different circuits - Creating multi-sheet flat designs - PCB layout and 3D Imaging - Introduction to Proteus and OrCAD Capture - Placement of components and Routing - Assigning reference designators - Design Rules checking - Adding inter sheet signal references - PCB stackup preparation-Characteristics impedance calculation-Signal Integrity analysis - Creating a Bill of Materials and Print layout - Gerber generation - PCB fabrication methods - Soldering Methods.

P: 30 TOTAL: 30 PERIODS

REFERENCES

1. Charles Hamilton, “A Guide to Printed Circuit Board Design” Elsevier, 2013.
2. Kraig Mitzner, “Complete PCB Design Using OrCAD Capture and PCB Editor” Newnes Publications, 2009.
3. Christopher T. Robertson, “Printed Circuit Board Designer's Reference” Prentice Hall Professional, 2004.
4. Eric Bogatin, “Signal integrity analysis simplified”, Prentice Hall Modern

Semiconductor Design Series, 2012.
5. http://www.ece.ucsb.edu/Faculty/Johnson/ECE189/Mentor2007/
6. http://read.pudn.com/downloads120/ebook/509920/High-speed%20Digital%20Design%20-%20Johnson%20&%20Graham.pdf

19EE17L EMBEDDED SYSTEM LABORATORY L T P C
0 0 2 1

COURSE OUTCOMES

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

CO1: interface GPIO, Timer, and ADC with external peripherals along with interrupt concept.(K3)

CO2: utilize serial communication protocols like UART, SPI and I^2C (K2)

LIST OF EXPERIMENTS

1. Program to interface on chip GPIO with external LED"s and switches
2. Program to control three different DC motors with different timings using delay routines and OnChip timers separately and compare both
3. Program to interface an Analog sensor with processor through OnChip ADC and display the measurement at external LCD.
4. Program to establish serial communication between two I^2C compatible boards
5. Program to establish serial communication between two UART compatible boards
6. Program to establish serial communication between two SPI compatible boards

P: 30 TOTAL: 30 PERIODS

19EE18L TECHNO COMMERCIAL PROJECT PROPOSAL L T P C
1 0 0 1

COURSE OUTCOMES

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

CO1: determine the technical feasibility and financial viability of the project (K2)

CO2: assess the risk associated with the project and enumerate imminent actions that are required to be taken (K3)

COURSE CONTENT

Introduction - Gathering Background Information - Components of a Proposal - Executive Summary - Statement of Need - Project Description - Methods - Staffing/Administration - Evaluation - Sustainability - Budget - Support and Revenue Statement - Budget Narrative - Organizational Information and Conclusion - Case studies.

L: 15 TOTAL: 15 PERIODS

REFERENCES

1. Jane C. Geever, "The Foundation Center's Guide to Proposal Writing", New York: The Foundation Center, 6th Edition, 2012.
2. Ellen Karsh and Arlen Sue Fox, "The Only Grant-Writing Book You'll Ever Need", Basic Books, 4th Edition, 2014.
3. http://grantspace.org/

19EE19L **VIRTUAL INSTRUMENTATION** **L T P C**
1 0 0 1

COURSE OUTCOMES

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

CO1: design of electronic circuits using Virtual Instrumentation. (K2)

CO2: develop the fundamental program for monitoring and control of process variable. (K2)

COURSE CONTENT

Concepts of Analog IO, Digital IO, Power supply, Counters, timers and PWM-Generation of signal using ELVIS **-** Design of RLC resonance circuit-Verification of logic gates- Design and implementation of adder and subtractor circuit **-** VI characteristics of Diode **-** VI characteristics of transistor amplifier-Analysis of Half wave rectifier with and without filter-Study of temperature measurement using ELVIS **-** Monitoring the displacement using LVDT-Vibration measurement using LVDT **-**Time response analysis of first order and second order process **-** Design of PID controller using ELVIS

L: 15 TOTAL: 15 PERIODS

REFERENCES

1. Rick Bitter, Taqi Mohiuddin ,Matt Nawrocki “Labview Advanced Programming Techniques” CRC press ,2 nd Edition ,2007
2. Gary Johnson, “LABVIEW Graphical Programming”, 2ndEdition, McGraw Hill, 2009.
3. S. Gupta, J.P. Gupta, “PC Interfacing for Data Acquisition and Process Control”, ISA, 2ndEdition, 2010.
4. Skolkoff, “Basic concepts of LABVIEW 4”, PHI, 1998

19EE20L **ELECTRICAL POWER CAPACITORS** **L T P C**
1 0 0 1

COURSE OUTCOMES

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

CO1: explain the general concepts and building blocks of capacitors. (K2)

CO2: summarize the various applications of capacitors. (K2)

COURSE CONTENT

Introduction: Capacitance – Basics of dielectric Materials – Dielectric Constant – Loss Angle – General Conceptions of Gaseous, Liquid and Solid Dielectrics – IS Standards – Solid Dielectrics, Composite Dielectrics, Electrolytes. Building Blocks of Capacitors: Condenser Tissue Paper – Polypropylene and Polyester Film – Aluminium Foil - Materials for Others Components – Discharge Resistors: Safety Consideration and Design – Housing of Capacitors – Impregnating Liquids – Manufacture of Paper and Plastic Film Capacitor. Application of Capacitors: DC and Energy Storage Capacitors –Series Capacitors for Power Quality Improvement –Harmonic Filters –Surge Protection Capacitors –Capacitors Voltage Transformers – Coupling Capacitors – Future capacitors.

L: 15 TOTAL: 15 PERIODS

REFERENCES

1. D.M.Tagore, “Electrical Power Capacitors – Design and Manufacturing”, Tata Mc-Graw Hill Publishing Company Ltd., 2002.
2. R.P. Deshpande, “Capacitors – Technology and Trends”, Tata Mc-Graw Hill

Publishing Company Ltd., 2012.
3. T.Longland, T.W.Hunt and W.A.Brecknell, “Power Capacitors Handbook”, Butterworths Publishers, 1984.
4. Ramasamy Natarajan, “Power System Capacitors”, CRC Press, 2005.
5. R.E. Marbury, “Power Capacitors”, Tata Mc-Graw Hill Publishing Company Ltd., 1949.

19EE21L INTERNET OF THINGS AND EMBEDDED SYSTEMS L T P C
1 0 0 1

COURSE OUTCOMES

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

CO1: Explain the fundamentals of IoT and its applications.(K1)
CO2: Develop simple applications using ARM processor and IoT.(K3)

COURSE CONTENT

Introduction – History of IoT - Characteristic of IoT – Machine to Machine communication – Web of Things – IoT protocols – IoT Vs M2M – Architecture of IoT - Connecting IoT to cloud – Cloud Storage for IoT – Data Analytics for IoT. ARM Based Embedded System Design: Overview of IoT supported Hardware platform–ARM Cortex Processor – Programming —Various Real time applications of IoT and ARM Processor – Generating different patterns on LED‟s – Sensor interfacing - Smart Traffic system.

L: 15 TOTAL: 15 PERIODS

REFERENCES

1. Pethuru Raj and Anupama C. Raman, “The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2017.
2. Jonathan W. Valvano, “Embedded Systems and introduction to ARM cortex – Microcontrollers” 5th Edition, CreateSpace Independent Publishing Platform, 2012.
3. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press, 2014.
4. Dr.Yifeng Zhu, “Embedded systems with ARM cortex - M microcontrollers in assembly language and C”. 2nd Edition, Man Press, 2015.

19EE22L HIGH VOLTAGE TESTING TECHNIQUES L T P C
0 0 2 1

COURSE OUTCOMES

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

CO1: perform the high voltage testing in insulating materials. (K2)
CO2: predict the behavior of different insulating material used in high voltage equipment. (K2)

LIST OF EXPERIMENTS

1. Study of high voltage testing objectives, classification, standards and specifications, correction factors.

2. Measurement of AC, DC and impulse breakdown voltage of insulating material
3. Partial discharge measurement with φ-q-n pattern
4. Measurement of flash over voltage for dry and wet 11kV outdoor insulator
5. Measurement of soil resistivity
6. Measurement of 50% critical impulse flashover voltages on the 11 kV insulator for positive / negative voltages.
7. Measurement of dielectric characteristics (Insulation Resistance, Absorption Index and Polarization Index) of insulating material
8. Investigate the effect of pollution severity on critical flashover voltage of 11 kV insulator.
9. Analyse the effect of dry band location of 11 kV insulator on electric field distribution using ANSYS.
10. Study on measurement of Radio interference voltage
11. Statistical Evaluation of Measured Results of breakdown phenomenon

i) Direct determination of probability values on disruptive discharge voltage

ii) Determination of the distribution function of a measured quantity

iii) Determination of the confidence limits of the mean value of the breakdown discharge voltage

iv) Determination of breakdown discharge voltages for given probability ranges 12.Study of multi stress ageing and life time analysis for different insulating medium

P: 30 TOTAL: 30 PERIODS

19EE23L	**QUALITY PRACTICES FOR SAFETY CRITICAL INSTRUMENTATION SYSTEM**	**L T P C** **1 0 0 1**

COURSE OUTCOMES

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

CO1: expose the students to requirement of standards and calibration techniques, safety and reliability mechanisms used in process industries. (K2)

CO2: impart knowledge about EMI and EMC problems in industrial measurements.(K2)

CO3: make the students to draw the specification of the industrial instruments and prepare the instrumentation project documents. (K2)

COURSE CONTENT

Standards and Calibration: Introduction to standards and calibration of measuring instruments - Guidelines of enclosure design.

EMI and EMC: Introduction - interference coupling mechanism - basics of circuit layout and grounding - concepts of interfaces - filtering and shielding - co-axial & twisted pair cable - electronic grounding.

Safety: Introduction - electrical hazards - hazardous areas and classification - nonhazardous areas – enclosures - NEMA types - fuses and circuit breakers. Protection methods: Purging - explosion proofing and intrinsic safety.

Reliability: Bathtub curve - reliability for series parallel systems - Mean Time To Failure (MTTF) - Mean Time To Repair (MTTR) - Mean Time Between Failures (MTBF) –

availability - redundancy and stand by.

Specifications: Specification of instruments - preparation of project documentation - process flow sheet - instrument index sheet - instrument specifications sheet – panel drawing and specifications, instrument specifications - Project procedure - schedules, vendor drawing, tender documentation - selection of measurement method and control panels.

L: 15 TOTAL: 15 PERIODS

REFERENCES

1. Noltingk B.E., Instrumentation Reference Book, Butterworth Heinemann, 2nd Edition, 1995.
2. Liptak B.G, Process Measurement and Analysis, Chilton Book Company, Radnor, Pennsylvania, 4th Edition, 2003.
3. Andrew W.G, Applied Instrumentation in Process Industries – A survey, Vol I & Vol II, Gulf Publishing Company, Houston, 2001
4. Patranabis D., Principles of Industrial Instrumentation, Tata McGraw Hill Publishing Company Limited, 3rd Edition, 2010.
5. Lawrence D. Goettsche, Maintenance of Instruments and Systems, International society of automation, 2nd Edition, 2005.
6. Henry W.Ott, Electromagnetic Compatibility Engineering, A John Wiley & Sons, INC., Publication, 2009

19EE24L SWITCHGEAR AND PROTECTION LABORATORY L T P C
0 0 2 1

COURSE OUTCOMES

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

CO 1: demonstrate the characteristics of various numerical protection relays. (K2)
CO 2: analyze power system problems using ETAP and SCADA software studies. (K2)

LIST OF EXPERIMENTS

1. Study and plotting Characteristics of IDMT type Induction over current relay
2. Testing on (i) Under Voltage Relay and (ii) Earth Fault Relay
3. Differential protection of transformer
4. Motor protection using numerical relay
5. Protection of Transmission line using Impedance relay
6. Load flow solution using software package
7. Simulation of various power system faults using software package

P: 30; TOTAL: 30 PERIODS

19EE25L ELECTRIC VEHICLES SIMULATION LABORATORY L T P C
0 0 2 1

COURSE OUTCOMES

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

CO1: Interpret the different models and configurations of EVs and HEVs. (K2)

CO2: Design the equivalent motor and battery model using MATLAB simulink package. (K2)

CO3: Design and simulate the power electronic converters and EVs controller unit using MATLAB simulink. (K2)

LIST OF EXPERIMENTS

1. Performance Study of EVs and HEVs based on datasheet.
2. Recent EV models and its configurations – A report
3. Architectural frame of EV using MATLAB/Simulink platform.
4. Simulation of E-vehicle Battery model design (Lithium Ion / Other) using MATLAB simulink.
5. E-vehicle Motor design and model (BLDC/DC/SR/PMSM/AC) using MATLAB simulink.
6. E-vehicle Motor Controller design using MATLAB simulink package.
7. Simulation and Experimental validation of Power electronic Converters for EV.
8. Design and simulation of Phase shifted full bridge converter for EV battery system.
9. Design of vehicle internal electronic control unit using MATLAB/Simulink.

P: 30 TOTAL: 30 PERIODS

19EE26L EV BATTERY DESIGN AND MODELING LABORATORY L T P C
0 0 2 1

COURSE OUTCOMES

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

CO1: Design and develop the equivalent model for various EV batteries with different power ranges using MATLAB simulink. (K2)

CO2: Analyze the different characteristics of EV batteries using simulink. (K2)

CO3: Design and Simulate Battery Management System. (K2)

LIST OF EXPERIMENTS

1. Study of various EV batteries and its characteristics using datasheet.
2. Design and development of equivalent circuit model for lead acid battery using MATLAB simulink.
3. Design and development of equivalent circuit model for Lithium-Ion battery using MATLAB simulink.
4. Design and development of equivalent circuit model for Nickel-Metal Hydride battery using MATLAB simulink.
5. Charging and discharging characteristics for Lead acid, Li-ion, Ni-MH batteries using MATLAB simulink platform.

6. SOC and SOH estimation of various batteries using MATLAB simulink.
7. Simulation of EV Battery Management System using MATLAB.
8. Simulation of Solar battery system with inverter using MATLAB.
9. Simulation of Hybrid Electric Vehicle (HEV) Model for a Passenger Car using MATLAB.
10. Study of Accessories like Battery Tester and BMS (Battery Monitoring System).
11. Study of Electric Vehicle Trainer kit.

P: 30 TOTAL: 30 PERIODS

19EE27L PYTHON PROGRAMMING IN RASPBERRY PI AND HARDWARE INTERFACING

L	T	P	C
0	0	2	1

COURSE OUTCOMES

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

CO1: Write python codes to interface sensors and actuators with raspberry pi.(K3)

CO2: Create IoT projects and communicate with IoT devices and cloud. (K3)

LIST OF EXPERIMENTS

1. Python programming using simple commands
2. Implementation of list, tuple and dictionary in Python
3. Setting up raspberry pi and booting raspberry pi with raspbian OS
4. Compiling Python codes in raspberry pi.
5. Controlling an output device – LED.
6. Data acquisition from an input device – Button.
7. Generating PWM signal – Fading of LED.
8. DC motor interfacing.
9. Interfacing temperature and humidity sensor.
10. Distance measurement using HCSR05 sensor.
11. Interfacing ADC – MCP3008 via serial peripheral interface.
12. Sending room temperature to Firebase Google IoT cloud.

P: 30; TOTAL: 30 PERIODS

REFERENCES

1. Gowrishankar S, Veena A, “Introduction to Python Programming” CRC Press, 2018.
2. Jeffrey Elkner, Allen B. Downey, Chris Meyers, “How to Think Like a Computer Scientist: Learning with Python” Samurai Media Limited, 2016.
3. Derek Molloy, “Exploring Raspberry Pi” Wiley, 2016.
4. https://docs.python.org/3/tutorial/
5. https://www.raspberrypi.org/learn/

19EE28L **ARDUINO PROGRAMMING** **L T P C**
0 0 2 1

COURSE OUTCOMES

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

CO1: Write C programming to interface sensors and actuators using Arduino (K3)

CO2: Create Arduino projects and communicate with IoT devices and Android App development (K3)

LIST OF EXPERIMENTS

1. Features of Arduino and pinout
2. LED and LCD Interfacing using Arduino
3. Analog and Digital I/O Interface using Arduino
4. DC motor Interfacing [Forward/Reverse]
5. Ultrasonic distance sensor Interfacing
6. Servo/Stepper Motor Interfacing
7. GSM/GPS Interfacing using Arduino
8. Bluetooth interfacing with Arduino
9. Simple mobile application development
10. Obstacle avoidance robot using Arduino
11. Line Following robot using Arduino
12. IR controlled appliances and interface
13. IOT application using NodeMCU ESP8266 Wi-Fi Module

P: 30 TOTAL: 30 PERIODS

19EE29L **HYDROGEN ENERGY AND FUEL CELLS** **L T P C**
1 0 0 1

COURSE OUTCOMES

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

CO1: Understand and demonstrate the hydrogen production technologies, storage methods and strategies for transition to hydrogen economy. (K2)

CO2: Explain the concepts and characteristics of various types of fuel cell (K2)

CO3: Describe the application of fuel cells. (K2)

COURSE CONTENT

Hydrogen Energy - Introduction to hydrogen economy, production, storage and transportation systems, hydrogen from fossil fuels, electrolysis of water, safety and environmental impacts, economics of transition to hydrogen systems. Fuel Cells - Concept, key components, physical and chemical phenomena in fuel cells, advantages and disadvantages, different types of fuel cells, characteristics. Fuel Cells - Application - Fuel cell usage for domestic power systems, large scale power generation, automobile and space.

L: 15 TOTAL: 15 PERIODS

REFERENCES

1. Fuel cell Fundamentals, John Wiley and sons, Willey 3rd Edition, 2016.
2. Fuel cells: Principles and Applications, Viswanathan B and Aulice Scibioh, University Press, 2008
3. Tomorrow's Energy – Hydrogen Fuel Cells and the Prospects for Cleaner Planet, Peter Hoffman, MIT, 2002.
4. Hydrogen – A fuel for Automatic Engines, Prashukumar G P, ISTE.

R – 2019 B.E - EEE

TRANS-DISCIPLINARY ELECTIVE COURSES – SELF STUDY

19TD05E **INDIAN ECONOMY** **L T P C**
0 0 0 3

COURSE OUTCOMES

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

CO 1: discuss the current economic development in India (K2)
CO 2: describe the key indicators of estimation of national income (K2)
CO 3: explain elementary concepts of economic planning and development in India (K2)
CO 4: discuss the concept of public finance and preparation of budget (K2)
CO 5: discuss the influence of infrastructure growth on economic development (K2)

UNIT I ECONOMIC DEVELOPMENT

Meaning - Measurement of Economic Development - Characteristic of underdeveloped and developed economies - Causes for Indian economic underdevelopment - Major issues in development - Strategies for economic development Import substitution and Export oriented strategies - Determinants of economic development.

UNIT II NATIONAL INCOME

The National Income and its estimates in India - Limitations of National income estimation - Trends in National income of India: Growth and Structure - Inter-state variations in National income - Income distribution - Measurement of poverty in India.

UNIT III ECONOMIC PLANNING

Planning and economic development in India - Planning models in India (Elementary concepts) - Capital formation - Growth of Public and Private sector in India – Industrial policies an assessment - Capital formation and domestic saving.

UNIT IV INDIAN PUBLIC FINANCE

Budgetary policies of the central government - Composition and trends in public revenue and expenditure - Expenditure control and government consumption expenditure - concepts of Budgetary deficits and implications - state budget.

UNIT V INFRASTRUCTURE AND ECONOMIC DEVELOPMENT

Power and energy - Transport system in India's economic development - Communication system in India - Urban infrastructure - Science and technology - Private investment in infrastructure - Outlook and prospects.

TEXT BOOKS

1. Dutt R, Sundaram K.P.M, "Indian Economy", S.Chand and Co., New Delhi, 65th edition, 2018.
2. Agarwal A.N, Agarwal M.K, "Indian Economy: Problems of Development and Planning", 41st Edition, New Age International Ltd., New Delhi, 2016.

REFERENCES

1. Paul A Samuelson, William D Nordhaus, Sudip Chaudhuri, Macroeconomic, McGraw-Hill Education, 20th edition, 2021
2. IC Dhingra, Indian Economy, Sultan Chand & Sons, 30th edition, 2019

19TD09E **INDIAN HISTORY** **L T P C**
0 0 0 3

COURSE OUTCOMES

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

CO1: illustrate the basics of Indian cultural heritage. (K2)

CO2: describe interaction between Ancient Indian cultural heritage and Islamic culture. (K2)

CO3: demonstrate Innovation by rulers of medieval period in the area of Administration, and their contact with the Europeans. (K2)

CO4: analyse modern Indian movements, Economic history and Impact of the British rule on India. (K2)

CO5: demonstrate the concepts of Indian National Movement and the history of freedom struggle in India. (K2)

UNIT I ANCIENTY INDIAN CULTURE

Ancient Indian Cultural Heritage - Social, Political, Legal and in the Area of Religion and Philosophy.

UNIT II LAW RELATING TO CULTURE

Law Givers and Dispute Resolution Systems in Ancient India (Administration of Justice in Ancient India - Pre-Islamic Period) - Law Relating to Culture - The Advent of Islam - Interaction between Ancient Indian Cultural Heritage and Islamic Culture - The Emergence of Synthetic Indian Culture.

UNIT III ADMINISTRATION IN ANCIENT INDIA

Innovation by Rulers of Medieval Period in the Area of General and Revenue Administration - District Administration - Court Systems - Indian Contact with the Europeans.

UNIT IV SOCIO-ECONOMIC HISTORY

Socio-Religious Reform Movements in Modern India and its Legal Culture - Economic History of India During British Period - Impact of the British Rule on India – Education.

UNIT EUROPEAN CULTURE IMPACT

Impact of European Culture and Liberal Thought on India – The Indian National Movement - The History of Freedom Struggle in India upto 1947.

TEXT BOOKS

1. Sreenivasa M.H.V, “History of India Part I and II”, JBA Publishers, New Delhi, 2015.
2. Agarwal R.C, Bhatnagar M, “Constitutional Development and National Movement of India”, S. Chand Publishers, New Delhi, revised edition, 2016.

REFERENCES

1. Altekar S, “State and Government in Ancient India”, Motilal Banarsidass Publishers, New Delhi, 7th edition, 2016.
2. B.R Grover, “A new look on Modern Indian History”, S. Chand Publishers, New Delhi, revised edition, 2016.

19TD10E SUSTAINABLE DEVELOPMENT AND PRACTICES L T P C
0 0 0 3

COURSE OUTCOMES

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

CO 1: recognize the sustainable development and the way to achieve the sustainable development. (K2)
CO 2: outline the concept, factors governing the sustainability and their linkages. (K2)
CO 3: explain the environmental impact assessment and environmental audit. (K2)
CO 4: describe the environmental planning and managing the resources. (K2)
CO 5: acquire the knowledge about the environmental problems and their solutions. (K2)

UNIT I SUSTAINABLE DEVELOPMENT

Need for Sustainability - 17 Sustainable Development Goals - Nine Ways to Achieve Sustainability - Economics as the Dismal Science - Population, Resources and Environment.

UNIT II CHALLENGES OF SUSTAINABLE DEVELOPMENT

Concept of Sustainability - Factors Governing Sustainable Development - Linkages among Sustainable Development, Determinants of Sustainable Development - Case Studies on Sustainable Development.

UNIT III ENVIRONMENT IMPACT ASSESSMENT AND AUDIT

Concepts-process-evaluation methodology-EIA and EMS integration-setting up of audit programme - typical audit process - carrying out the audit-benefits of environmental auditing-environmental audit programmes in India.

UNIT IV ENVIRONMENTAL PLANNING

Introduction - Perspective of Environmental Planning - land resource development planning - Planning and managing the natural resources - landscape ecological planning - information and decision of environmental planning - Land use policy in India.

UNIT V ENVIRONMENTAL EDUCATION

Knowledge about the environment - Knowledge about the environment and population growth -Knowledge about the solution and environmental problems - Environmental education (EE) – Strategies for EE – Models for future Environmental Education Systems.

TEXT BOOKS

1. Rogers P, Jalal K.F, Boyd J.A, “An Introduction to Sustainable Development”, Earth scan Publications Ltd., UK, 4th edition, 2013.
2. Santra S.C,” Environmental Science”, 3rd Edition, New Central Book Agency (P) Ltd., London, 2013.

REFERENCES

1. Stavins R.N. “Economics of the Environment: Selected Readings”, 5th Edition, W.W. Norton and Company, New York, 6th edition, 2012.
2. Sachs J.D, “The Age of Sustainable Development”, Columbia University Press, New York, 2015.

19TD11E WOMEN IN INDIAN SOCIETY L T P C
0 0 0 3

COURSE OUTCOMES

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

CO1: Demonstrate historical perspective about women in Indian society. (K2)
CO2: Explain social problems of women. (K2)
CO3: Understand the legislation for women protection in India. (K2)
CO4: Demonstrate the involvement of women literacy, career and politics. (K2)
CO5: Analyze the role of NGO's in women empowerment. (K2)

UNIT I INTRODUCTION

A Historical Perspective - Early Vedic, Colonial and Modern Periods - Position of Women in Contemporary India.

UNIT II SOCIAL ISSUES

Issues of Girl Child - Female Infanticide and Feticide, Sex Ratio, Child Marriage, Dowry and Property Rights - Women's Health and Birth Control - Reproduction - Violence against Women - Domestic Violence - Female Headed Households - Women in the Unorganized Sector of Employment - Women's Work- Status and Problems - Problems of Dalit Women.

UNIT III PROTECTIVE LEGISLATION FOR WOMEN

Protective Legislation for Women in the Indian Constitution - Anti Dowry, SITA, PNDT, And Prevention Sexual Harassment At Workplace (Visaka Case) - Domestic Violence (Prevention) Act.

UNIT IV WOMEN AND EDUCATION

Formal and Non-Formal Literacy - Post Literacy - Vocational Training - Dual Career Modernization – Women and Politics - Political Status - Global Movements and Indian Movements.

UNIT V ROLE OF NGO'S IN WOMEN EMPOWERMENT

Gender Economy – Role of women in technology and education - All India Women's Conference (AIWC) – Women's India Association (WIA) - National Council of Women in India (NCWIE) - Indian Association of Women's Studies – Women Development Cells - Self Help Groups.

TEXT BOOKS

1. Majumdar M, "Social Status of Women in India", Wisdom Press, New Delhi, 2012.
2. Harish R, Harishankar V.B, "Re-Defining Feminisms", Rawat Publications, Jaipur, 2011.

REFERENCES

1. Rathod P.B, "An Introduction to Women's Studies", ABD Publishers, Jaipur, 2010.
2. Ray R, "Hand Book of Gender", Oxford University Press, New Delhi, 2012.

19TD13E LEADERSHIP AND PERSONALITY DEVELOPMENT L T P C
0 0 0 3

COURSE OUTCOMES

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

CO 1: identify the various leadership skills. (K2)
CO 2: understand group dynamics and factors influencing the team performance. (K2)
CO 3: describe the personality dimensions based on personality theories. (K2)
CO 4: explain personality determinants and personality types. (K2)
CO 5: apply effective training program for personality development. (K2)

UNIT I INTRODUCTION

Leadership – Meaning, Concepts and Myths about Leadership, Components of Leadership- Leader, Followers and Situations - Leadership Skills – Basic Leadership Skills - Building Technical Competency - Advanced Leadership Skills - Team Building for Work Teams - Building High Performance Teams.

UNIT II TEAMS AND LEADERSHIP

Assessing Leadership & Measuring Its Effects - Group- Nature, Size, Roles, Norms, Cohesion, and Stages of Group Development - Teams and their Leadership – Effective Team Characteristics and Team Building - Ginnetts Team Effectiveness Leadership Model.

UNIT III PERSONALITY

Personality - Meaning, Concept, Personality Patterns, Symbols of Self, Moulding the Personality Pattern, Persistence & Change - Personality & Personal Effectiveness - Psychometric Theories – Cattell and Big Five - Psychodynamic Theories - Carl Jung and MBTI - Transactional Analysis - Johari window - Personal Effectiveness.

UNIT IV PERSONALITY DETERMINANTS

Personality Determinants – Heredity and Environment – Types of personality.

UNIT V PERSONALITY TRAINING

Concept, Role, Need, Importance and types of personality Training - Understanding Process of Learning - Developing an Integrated Approach of Learning in Training Programme - Training Needs Assessment.

TEXT BOOKS

1. Yukl G, “Leadership in Organisations”, 8th Edition, Pearson Education Limited, England, 2013.
2. Girish Batra, Experiments in Leadership, Chennai: Notion Press, 2018

REFERENCES

1. Mitesh Khatri, Awaken the Leader in You, Mumbai: Jaico Publishing House, 2013.
2. Stephen P. Robbins and Timothy A. Judge, “Organizational Behavior”, Prentice Hall, 16th Edition, 2014